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Cover. Part of plate 1 from *Genera et Species Trichopterorum, pars Altera*, 1857 by Frederico Antonio Kolenati. Figure 8 illustrates *Psychomyia annulicornis* Pictet subsequently selected as type of the genus and family by Ross 1944. The first true member of the family Psychmyiidae from Australia is reported in this volume of the *Memoirs* by Arturs Neboiss, whereas the previously included genus *Ecnomus*, now assigned to its own family, is revised by David Cartwright.

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Instructions to Authors

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Two copies of the manuscript with accompanying plates and figures should be submitted to the Scientific Editor, Museum of Victoria, Swanston Street, Melbourne, Victoria 3000. Authors should consult a recent volume of the *Memoirs* to aquaint themselves with format.

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In taxonomic papers synonymies should be of the short form: taxon, author, year, pages, figures. A period and dash must separate taxon and author except in the case of reference to the original description.

Photographs must have clear definition and may be submitted as either glossy or flat prints at the actual size for reproduction. Line drawings for text-figures should be in black ink on white card or drawing film. Maximum full-page size is 140 mm wide by 193 mm; single column width is 67 mm. Clear lettering must be inserted. Original drawings up to twice final size are acceptable.

CONTENTS

Memoirs of the Museum of Victoria 51: 1–48 (1990) ISSN 0814-1827

THE AUSTRALIAN SPECIES OF *ECNOMUS* McLACHLAN (TRICHOPTERA: ECNOMIDAE)

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Abstract

Cartwright, D.I., 1990. The Australian species of *Ecnomus* McLachlan (Trichoptera: Ecnomidae). *Memoirs of the Museum of Victoria* 51(1): 1–48.

The Australian species of the caddisfly genus *Ecnomus* McLachlan are revised. Descriptions, distribution maps and keys are provided for males of 40 species, all of which are endemic; 34 are newly described. Females of 12 southern Australian species are described.

Introduction

The family Ecnomidae was proposed by Lepneva (1956) and independently by Marlier (1958). Kimmins (1957) also established characters for separating ecnomids from psychomiids. Neboiss (1977) adequately summarized establishment of the family Ecnomidae and provided a family diagnosis.

The genus *Ecnomus* McLachlan is distributed primarily in the Ethiopian (about 50 species, Barnard and Clark, 1986) and Oriental regions (about 40 species, Fischer, 1960–1973) and Australia (40 species, this study) and is unknown from the Nearctic and Neotropical regions.

Ecnomus species are diverse and widespread throughout Australia, although only six species have been described previously. The identity of the first of these, *E. continentalis* Ulmer from north Queensland (Ulmer, 1916) has been the subject of considerable confusion. Specimens proported to be *E. continentalis* have been figured from South Australia (Mosely and Kimmins, 1953), Tasmania (Neboiss, 1977) and south-east Queensland (Neboiss, 1978). Neboiss (1982) figured and redefined *E. continentalis*, and described two new species, *E. pansus* Neboiss to accomodate the South Australian specimen, and *E. cygnitus* Neboiss for the SE-Queensland specimen. Other species previously described are *E. tillyardi* Mosely (Mosely and Kimmins, 1953) and *E. russellius* Neboiss, 1977 both from Tasmania and *E. turgidus* Neboiss, 1982 from south-west Australia.

Species recognition is based on differences in male and female genitalia, although positive identification usually requires clearing of genitalia. The usual problem of association of males and females is compounded by the presence of up to ten species at one site in each of the Kimberley and Kakadu regions and commonly 3–7 species at other northern Australian sites. In southern Australia often two or three or up to five species have been collected at some sites. Males and females of twelve southern Australian species have been associated, mainly through breeding out of larvae.

Materials and Methods

Most of the material examined during the present study is held in the collections of the Museum of Victoria, Melbourne (NMV). Loan material from the Queensland Museum, Brisbane (QM), the Northern Territory Museum of Arts and Sciences, Darwin (NTM), the Australian National Insect Collection, Canberra (ANIC) and the Australian Museum, Sydney (AM), was also examined. All specimens, including types, mentioned in the text are lodged in the NMV unless stated otherwise. Repositories for type material of previously described species include the Naturhistoriska Riksmuseet, Stockholm (NRS), the British Museum of Natural History, London (BMNH) and the Western Australian Museum, Perth (WAM).

Descriptions of the six established species are based on new material after comparison with the original descriptions. In most cases the figured specimen has also been compared with the type specimen.

Names of prolific collectors have been abbreviated in the text as follows: J.E. Bishop – J.E.B.; J. Blyth – J.B.; A. Neboiss – A.N.; P. Suter – P.S.; A. Wells – A.W.

All figured specimens are identified by the author's notebook number, with the prefix CT-; occasional PT-numbers refer to the notebook used by Dr A. Neboiss (NMV). Genitalia were drawn from specimens macerated in KOH, cleared and transferred to glycerol for drawing. The figures of wing venation were prepared with the aid of a camera lucida, from detached wings, denuded of hair and mounted in glycerol as temporary mounts (Neboiss, 1977).

Terminology used follows that of Nielsen (1957, 1978, 1981) and Barnard and Clark (1986). Abbreviations for genitalic parts are as shown in Figs 1, 2, 83, 84.

Characteristics of the Australian Fauna

Typically in the Australian fauna the "southern" species are larger (anterior wing length (AWL) male, usually greater than 5 mm), have darker wings (usually brown to dark greyish-brown with paler irrorations), superior appendages of males tend to be long. The "northern" species are commonly smaller (AWL male usually less than 5 mm), wings paler (typically fawn to brown with paler irrorations), superior appendages of males mostly broad-based and often short. "Southern" species with ranges extending into north Queensland and the Northern Territory, are noticeably smaller and paler in the northern parts of their range. Size and wing colour can be useful characters, but are variable. Wing colour should also be considered with caution since the colour fades in alcohol. Wing venation is conservative and is therefore not useful for species separation. The chief discriminators are found in male and female genitalia.

Superior appendages of males are characterized by a field of mesally-directed spiny setae, usually restricted to the apices. Inferior appendages differ between species, and are a good taxonomic character for species separation. Paired parameres are found in all species except one (where they have apparently fused together). The phallus is usually obliquely narrowed subapically, and in many species a pair of spines is embedded in the ventral surface subapically. A pair of mesoventral processes is located on segment ten. Three species have a pair of processes on the posterolateral margin of segment nine. The shape of the ventral plates vary slightly in females. Many species also have small "pockets", which differ in their shape and position on the ventral plate. These "pockets" seem to match the shape and position of the mesal projection on the inferior appendage of the corresponding male, which during copulation forms a "key in lock" mechanism (Figs 107, 108).

On the basis of male genitalia, many Australian species can be placed into species groups, however many other species, although distinctive, are intermediate between several groups. Therefore in this study the species are not grouped formally.

Ecnomus McLachlan

Ecnomus McLachlan, 1864: 30. — Ulmer, 1907: 190. — Mosely and Kimmins, 1953: 378. — Neboiss, 1977: 54.

Type species. Philopotamus tenellus Rambur, 1842 (original designation).

Diagnosis (revised after Neboiss, 1977). Maxillary palpi with segment 1 short, segments 2, 3 and 4 successively slightly longer than preceding segment, segment 5 about as long as all other segments together. Mesoscutum and scutellum each with a pair of rounded warts. Anterior wings with R1 forked at apex; apical forks 1, 2, 3, 4 and 5 present, fork 1 short; discoidal, median and thyridial cells present. Posterior wings slightly narrower than anterior wings; forks 2 and 5 present; discoidal cell absent. Tibial spurs 3:4:4.

Remarks. The other ecnomid genus in Australia, *Ecnomina* Kimmins is distinguished from *Ecnomus* by the absence of fork 1 in the anterior wing, presence of fork 3 and the discoidal cell in the posterior wing, and abdominal segments 9 and 10 elongate in the female.

Checklist of Australian species of *Ecnomus*

Ecnomus ancisus sp. nov.
E. apiculatus sp. nov.
E. bishopi sp. nov.
E. blythi sp. nov.
E. centralis sp. nov.
E. clavatus sp. nov.
E. continentalis Ulmer, 1916
E. cuspidis sp. nov.
E. cygnitus Neboiss, 1982
E. deani sp. nov.
E. digrutus sp. nov.
E. ingibandi sp. nov.
E. jimba sp. nov.
E. kakaduensis sp. nov.
E. karakoi sp. nov.
E. karawalla sp. nov.

E. kerema sp. nov.
E. kinka sp. nov.
E. kitabal sp. nov.
E. larakia sp. nov.
E. miriwud sp. nov.
E. myallensis sp. nov.
E. neboissi sp. nov.
E. nibbor sp. nov.
E. pakadji sp. nov.
E. pansus Neboiss, 1982
E. pilbarensis sp. nov.
E. russellius Neboiss, 1977
E. tillyardi Mosely, 1953
E. tropicus sp. nov.
E. tridigitus sp. nov.
E. turrbal sp. nov.
E. turgidus Neboiss, 1982
E. veratus sp. nov.
E. volsellus sp. nov.
E. walajandari sp. nov.
E. wagengugurra sp. nov.
E. wellsae sp. nov.
E. woronan sp. nov.
E. yabbura sp. nov.

Key to Males of Australian *Ecnomus* McLachlan

Critical distinguishing characters used in the key are denoted by an arrow on the figures.

1. Process present on postero-lateral margin of segment nine (Figs 1, 3, 5) 2
— Without process on segment nine (Figs 7, 10) 4
2(1). Superior appendage with ventrally directed projection on basiventral margin (Fig. 1) N-WA ..... *E. ingibandi* sp. nov.
— Superior appendage without ventrally directed projection (Figs 3, 5) 3
3(2). Superior appendage in lateral view, broadbased, length less than 1.5× width (Fig. 3) NE-NSW, E-Qld, N-WA ..... *E. kitabal* sp. nov.
— Superior appendage in lateral view, elongated, length greater than 2× width (Fig. 5) N-WA, N-NT ..... *E. jimba* sp. nov.
4(1). Parameres fused to form a single elongated, downcurved process (Figs 7, 8) N-WA, N-NT, NE-Qld ..... *E. veratus* sp. nov.
— Parameres not fused (Figs 11, 13) 5
5(4). Superior appendage in lateral view, broadbased, strongly narrowed in distal third, with ventrally directed projection on basiventral margin (Figs 10, 12) 6
— Without above combination of characters (Figs 14, 45, 51, 67) 7
6(5). Inferior appendage in ventral view with smoothly curved mesal margin, broadest in basal half (Fig. 11), in lateral view with slender, digitiform apical projection (Fig. 10) S-WA, SA, Vic., NSW, Qld, S-NT ..... *E. turgidus* Neboiss
— Inferior appendage in ventral view with shallowly incised mesal margin, broadest in apical half (Fig. 13), in lateral view, with robust, digitiform subapical projection (Fig. 12) N-WA, N-NT ..... *E. digrutus* sp. nov.
7(5). Inferior appendage in ventral view with 2 distinct mesal projections (Figs 15, 17, 19, 21, 23) 8
— Inferior appendage in ventral view with only 1 or no distinct mesal projection (Figs 25, 50) 12
8(7). Inferior appendage in ventral view, with apex rounded to bluntly angled (Figs 15, 17) 9
— Inferior appendage in ventral view, with apex acute (Figs 19, 21, 23) 10
9(8). Inferior appendage in ventral view, short, robust, length about 2× width (Figs 15, 15a) N-WA, N-NT, NE-Qld ..... *E. woronan* sp. nov.
— Inferior appendage in ventral view, length about 3× width (Fig. 17) N-NT, N-WA ..... *E. kakaduensis* sp. nov.

10(8). Inferior appendage triangular in lateral view (Fig. 18), in ventral view, mesal projections short (Fig. 19) NE-NSW, E-Qld . *E. wellsae* sp. nov.
— Inferior appendage bifid apically in lateral view (Figs 20, 22), in ventral view mesal projections long (Figs 21, 23) 11
11(10). Inferior appendage in ventral view slender, length about 3× width (Fig. 21); superior appendage constricted distally, apex downturned; paramere without bulbous tip (Fig. 20) NE-NSW, SE-Qld ..... *E. tridigitus* sp. nov.
— Inferior appendage in ventral view short, robust, length about 2× width (Fig. 23); superior appendage rod-like in lateral view, slightly tapered distally; paramere with bulbous tip (Fig. 22) E-Vic., SE-Qld ..... *E. neboissi* sp. nov.
12(7). Inferior appendage in lateral view, broadest in middle (Figs 24, 26, 28), middle width in lateral view greater than twice middle width in ventral view (Figs 24, 25, 26, 27, 28, 29); paramere robust, apex curved downwards at right angles to form a distinct hook (Figs 24, 26, 28) 13
— Not above combination (Figs 51, 52, 65, 66, 71, 72) 15
13(12). Inferior appendage bifid apically in ventral view (Fig. 25) E-Qld, N-NT ..... *E. turrbal* sp. nov.
— Inferior appendage in ventral view, with slender apical projection only (Figs 27, 29), or rounded apex and sub-apical digitiform projection (Fig. 27a) 14
14(13). Inferior appendage in lateral view, sub-trapezoidal in shape, proximal angle of upper margin obtuse (Figs 26, 26a), distal angle produced into a dorso-mesally directed digitiform projection (Figs. 26, 26a, 27, 27a) N-WA, N-NT, E-Qld ..... *E. cuspidis* sp. nov.
— Inferior appendage in lateral view, trigonal in shape, proximal angle of upper margin forms a right angle, (Fig. 28), in ventral view, distal angle produced into a mesally directed digitiform projection (Fig. 29) N-WA ..... *E. bishopi* sp. nov.
15(12). Inferior appendage in ventral view, with 1 distinct mesal projection (Figs 31, 33, 40) 16
— Inferior appendage in ventral view, without a distinct mesal projection (Figs 52, 54) (inferior appendage may have shallow mesal concavity in distal half, but lacks distinct mesal projection (Figs 62, 68)) 24
16(15). Genitalia in lateral view, with inferior appendage longer than superior appendage (Fig. 30); inferior appendage with mesal projection in basal third (Fig. 31) N-WA, N-NT, E-Qld ..... *E. clavatus* sp. nov.
— Genitalia in lateral view, with inferior appendage equal to, or shorter than, superior appendage (Figs 34a, 36); inferior appendage usually with mesal projection in distal 2/3 (Figs 35a, 37) 17
17(16). Inferior appendage in ventral view broadbased, with robust mesal projection, apex tapered strongly (Figs 33, 35a, 37) 18
— Inferior appendage in ventral view, not as above (Figs 40, 44) 20
18(17). Inferior appendage in ventral view, with apex of mesal projection in distal half (Fig. 33) E-Vic., E-NSW ..... *E. deani* sp. nov.
— Inferior appendage in ventral view, with apex of mesal projection in basal half (Figs 35a, 37) 19
19(18). Inferior appendage in ventral view, straight distally (Figs 35a, b) Tas., SE-SA, Vic., NE-NSW ..... *E. tillyardi* Mosely
— Inferior appendage in ventral view, mesally directed distally (Fig. 37) E-Vic., E-NSW, SE-Qld ..... *E. volsellus* sp. nov.
20(17). Inferior appendage in ventral view slender, length about 3× width, mesal projection separated widely from the apical angle forming a deep, rounded concavity (Figs 40, 42); paramere distally slender, depressed (Figs 39, 41) 21

— Inferior appendage in ventral view short, robust, length about 2× width, mesal projection narrowly separated from the apical angle forming a shallow or V-shaped concavity (Figs 44, 46, 48); paramere curved downwards distally to form a distinct hook (Figs 43, 45, 47) 22

21(20). Superior appendage in lateral view elongated, length about 5× width, apex slightly dilated (Fig. 39) S-WA, SA, Vic., NSW, Qld, NT ..... *E. pansus* Neboiss

— Superior appendage in lateral view long, robust, length about 3× width, broadest in median section, tapered slightly distally (Fig. 41) SE-SA, Tas., Vic., E-NSW, E-Qld ..... *E. cygnitus* Neboiss

22(20). Paramere distally curved downwards at right angles to form a distinctive, elongated hook (Fig. 43) NE-Qld ..... *E. kerema* sp. nov.

— Paramere distally curved downwards at right angles to form a short hook (Figs 45, 47) 23

23(22). Inferior appendage in ventral view, with long digitiform subapical mesal projection, narrowly separated from the apical angle, forming a deep notch (Figs 46, 46a) SE-SA, Vic., E-NSW, E-Qld, S-NT ..... *E. continentalis* Ulmer

— Inferior appendage in ventral view, with short subapical mesal projection, separated from the apical angle, forming a shallow cavity (Fig. 48) E-Vic., E-NSW ..... *E. nibbor* sp. nov.

24(15). Superior appendage in lateral view, broadbased with strong constriction at about middle, minimum width in distal third less than 1/4 maximum width in basal half (Figs 49, 51) 25

— Superior appendage in lateral view, if broadbased then gradually tapered distally, width at distal third at least 1/3 maximum width in basal half (Figs 53, 59, 77) 26

25(24). Superior appendage in lateral view, with dilated apex (Fig. 49) N-WA, N-NT ..... *E. ancisus* sp. nov.

— Superior appendage in lateral view, without dilated apex (Fig. 51) N-WA, N-NT ..... *E. blythi* sp. nov.

26(24). Inferior appendage in lateral view, with dorsal digitiform projection (Figs 53, 55) 27

— Inferior appendage in lateral view, without dorsal projection (Figs 57, 59) 28

27(26). Inferior appendage in lateral view, tapered distally, with dorsal projection at about distal third (Fig. 53) N-SA, NT, SW-Qld, NW-NSW ... *E. centralis* sp. nov.

— Inferior appendage in lateral view, not tapered distally, with dorsal projection at about basal third (Fig. 55) SE-Qld, Vic. ..... *E. myallensis* sp. nov.

28(26). Inferior appendage in lateral view, long and slender, length greater than 6× width (Fig. 57) N-WA, N-NT ..... *E. yabbura* sp. nov.

— Inferior appendage in lateral view, shorter, more robust, length less than 5× width (Figs 59, 61) 29

29(28). Superior appendage with mesally directed spiny setae spread at least half way along mesal margin (Fig. 60) N-WA, N-NT . *E. miriwud* sp. nov.

— Superior appendage with mesally directed spiny setae clumped in distal third (Figs 62, 72) 30

30(29) Meso-ventral process of segment 10, with apex produced into 3 small knobs each with an attached hair, resulting in a 3-pronged shape (Fig. 61) NE-NSW, NE-Qld ..... *E. wagengugurra* sp. nov.

— Meso-ventral process of segment 10, with apex simple, but usually with 2 or 3 attached hairs (Figs 67, 81) 31

31(30). Inferior appendage dorso-ventrally flattened, width in middle in ventral

view, broader than width in middle in lateral view (Figs 63, 64, 65, 66, 67, 68); large insect, AWL greater than 5 mm 32

— Inferior appendage not dorso-ventrally flattened, width in middle in ventral view, narrower or equal to width in middle in lateral view (Figs 69, 70, 81, 82); small insect, AWL less than 5 mm 34

32(31). Superior appendage in lateral view, with downwardly produced basiventral angle extended into a short projection; paramere in lateral view curved downward at right angles to form a distinct hook (Figs 65, 67) 33

— Superior appendage in lateral view, with downwardly produced basiventral angle not extended into a projection; paramere in lateral view slightly bulbous, apex not curved downwards (Fig. 63) SW-Vic ..... *E. karawalla* sp. nov.

33(32). Phallus in lateral view, tapered distally, with a distinctive, laterally-compressed apical process (Fig. 65); inferior appendage in ventral view, length nearly 3× width (Fig. 66) Tas., Vic., E-NSW, SE-Qld ..... *E. russellius* Neboiss

— Phallus in lateral view, obliquely narrowed distally with a short apical process (Fig. 67); inferior appendage in ventral view short, robust, length about 2× width (Fig. 68) SW-Vic ..... *E. karakoi* sp. nov.

34(31). Inferior appendage especially in ventro-lateral view, with bifid apex (Figs 69, 70) NE-Qld, N-NT, N-WA ..... *E. tropicus* sp. nov.

— Inferior appendage with apex not bifid (Figs 72, 74) 35

35(34). Inferior appendage in lateral view with slender digitiform process apically (Figs 71, 71a) N-WA, SE-Qld ..... *E. apiculatus* sp. nov.

— Inferior appendage in lateral view either rounded or with a short, broad-based process apically (Figs 77, 79) 36

36(35). Inferior appendage in ventral view, with inner margin subapically inflected towards middle of apical projection (Figs 74, 76) 37

— Inferior appendage in ventral view, with inner margin subapically inflected towards mesal margin of apical projection (Figs. 78, 82) . 38

37(36). Inferior appendage in ventral view rod-shaped, length about 4× width (Fig. 74) N-WA, N-NT, NE-Qld ..... *E. kinka* sp. nov.

— Inferior appendage in ventral view length about 2.5× width, not parallel-sided, inner margin curved (Fig. 76) N-WA, N-NT, NE-Qld ..... *E. pilbarensis* sp. nov.

38(36). Superior appendage in lateral view short, broadbased, length less than 2× width (Fig. 77) N-WA, N-NT, NE-Qld ..... *E. larakia* sp. nov.

— Superior appendage in lateral view long, length greater than 3× width (Figs 79, 81) 39

39(38). Inferior appendage in ventral view slender, tapered gradually distally, inflected (Fig. 80); paramere in lateral view robust (Fig. 79) NE-Qld. ..... *E. pakadji* sp. nov.

— Inferior appendage in ventral view robust, broadbased, narrowed markedly in distal third (Fig. 82); paramere in lateral view, slender (Fig. 81) N-WA, N-NT ..... *E. walajandari* sp. nov.

Ecnomus ingibandi sp. nov.

Figures 1, 2

Type material. Holotype male, Western Australia, Millstream, Fortescue River S of Roebourne, 12 Nov 1978, M.S. and B.J. Moulds (NMV, T-10001).

Paratypes. 1 male (specimen CT-053 figured), collected with holotype; 1 male, Western Australia, Crossing Pool, Millstream, Pilbara, 21 Oct 1979, J. Blyth (NMV).

Description. Male. Wings uniformly pale fawn. Pair of processes on distal margin of abdominal segment nine ventrally directed, slightly tapered apically (Fig. 1). Genitalia with superior appendage short, in lateral view broadbased, about as

long as wide, downwardly pointed basiventral angle produced into a small digitiform projection on ventral margin near base. Inferior appendage longer than superior appendage (Fig. 1), in ventral view length about 3× width, slightly tapered distally (Fig. 2). In lateral view, paramere gradually depressed distally; phallus without ventral swelling, upper apical angle extended to a short point (Fig. 1).

Female. Unknown.

Length of anterior wing: male 3.6–3.9 mm.

Etymology. Named after the Ingibandi aboriginal tribe who inhabited the region including the type locality.

Distribution. WA (Pilbara region – type locality only) (Fig. 110).

Remarks. Only three males are known, all collected from one locality. The species is similar to *E. kitabal* sp. nov., and *E. jimba* sp. nov., in that males of all three species have a pair of processes on segment nine. *E. ingibandi* has a ventral projection on both superior appendages.

Ecnomus kitabal sp. nov.

Figures 3, 4

Type material. Holotype male, New South Wales, Clarence River at Yates Crossing, 26 Oct 1981, Wells and Carter (NMV, T-10003).

Paratypes. 14 males (specimen CT-044 figured), collected with holotype (NMV).

Other material examined. Queensland. 3 males, Brisbane R. nr Kholo, 9 Mar 1973, M.H. Colbo; 1 male, Brisbane R., Kholo, 14 Sep 1972, M.H. Colbo; 1 male, same loc., 9 Mar 1973, M.H. Colbo; 1 male, 10 km S of Innisfail, 17°34′S, 146°01′E, 18 Nov 1988, K. Walker; 1 male, Mulgrave R., W of Gordonvale, 29 Apr 1979, A.W.; 4 males, Laura, Cape York Peninsula, 7 Oct 1979, M.S. and B.J. Moulds; 2 males, McLeod R., 15 km W of Mt Carbine, 22–23 Jun 1975, S.R. Monteith (ANIC).

Western Australia. 1 male (genitalia slightly damaged), Maggie Ck, 3 Feb 1978, J.E.B.

Description. Male. Wings pale fawn to brown with paler irrorations. Pair of processes on segment nine in ventro-lateral view, slender. Genitalia with superior appendage short, in lateral view broadbased, narrowed distally; inferior appendage as long as superior appendage (Fig. 3), in ventral view, length about 3× width, tapered slightly distally (Fig. 4); paramere gradually depressed distally; phallus (Fig. 3), essentially as for *E. ingibandi*.

Female. Unknown.

Length of anterior wing: male 3.8–5.2 mm.

Etymology. Named after the Kitabal aboriginal tribe who inhabited the region including the type locality.

Distribution. NE-NSW, E-Qld, N-WA (Kimberley region) (Fig. 110).

Remarks. Males are similar to *E. ingibandi* and *E. jimba* sp. nov., in the presence of a pair of processes on segment nine, but differ in the form of the superior appendages. The shape of the superior and inferior appendages are similar to *E. larakia* sp. nov., and *E. miriwud* sp. nov., but *E. kitabal* can be separated by the processes on segment nine. The apices of the inferior appendages are slightly more pointed in N-Western Australian and NE-Queensland specimens.

Ecnomus jimba sp. nov.

Figures 5, 6

Type material. Holotype male, Western Australia, Ord River, 9 km N Kununurra, 19 Sep 1979, J. Blyth (NMV, T-10018).

Paratypes. 20 males (specimen CT-046 figured), collected with holotype (NMV).

Other material examined. Western Australia. 25 males, Granite Ck, Kununurra–L Argyle Hwy, 2 Feb 1978, J.E.B.; 6 males, Mitchell Plateau, Camp Ck at crusher, 15 Feb 1979, J.E.B.; 2 males, same loc., 18 Feb 1979, J.E.B.; 2 males, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 3 males, Four Mile Ck, 2 Feb 1977, J.E.B.; 1 male, Stonewall Ck, 4 Feb 1978, J.E.B.

Northern Territory. 3 males, Katherine Gorge Nat. Pk, 13 Aug 1979, J.B.; 40 males, South Alligator R. nr Koolpin Crossing, 14 Oct 1987, P. Dostine; 13 males, SAR, site 1, 14 Jun 1987, P. Dostine; 5 males, same loc., 30 Sep 1988, P. Dostine; 13 males, same loc., October 1988, P. Dostine; 3 males, ARRS South Alligator R. at Gimbat OSS Station, 28 Apr 1988, P. Dostine; 2 males, same loc., 24 May 1988, A.W., P.S.; 1 male, ARRS South Alligator R. below Fisher Ck jn, 24 May 1988, A.W., P.S.; 4 males, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, A.W., P.S.; 9 males, same loc., 19–20 Apr 1989, A.W., P.S.; 3 males, ARRS South Alligator R. below BHP camp, 25 May 1988, A.W., P.S.; 30 males, ARRS Kambolgie Ck, 25–26 May 1988, A.W., P.S.; 14 males, same loc., 25 May 1988, P.S., A.W.; 1 male, Jim Jim Ck on Kakadu Hwy, 28 May 1988, P.S., A.W.; 1 male, ARRS Graveside Ck, 18 Jul 1988, P. Dostine; 1 male, SAR, Rock Hole Ck, November 1988, P. Dostine; 5 males, ARRS Ck 5 km W of OSS Gimbat Field Station, 19 Apr 1989, A.W., P.S.; 7 males, McArthur R., 48 km SSW of Borroloola, 16°27′S, 136°05′E, 29 Oct 1975, J.C. Cardale (ANIC).

Description. Male. Wings pale fawn. In ventro-lateral view, processes on segment nine broadbased, tapered distally. Genitalia with superior

appendage long, in lateral view length nearly 3× width, broadest in basal half, tapered gradually distally (Fig. 5); in ventral view, inferior appendage length about 3× width, with small digitiform apical process (Fig. 6). In lateral view, paramere almost straight with slightly dilated apex. Phallus (Fig. 5), similar to *E. ingibandi*.

Female. Unknown.

Length of anterior wing: male 2.8–3.4 mm.

Etymology. Jimba – Western Australian aboriginal word for little (wing size).

Distribution. N-WA (Kimberley region), N-NT (Fig. 110).

Remarks. A small, common northern Australian species. The male also has a distal pair of processes on abdominal segment nine, but differs from *E. ingibandi* and *E. kitabal* mainly in the elongate superior appendages. The form of the superior and inferior appendages, and parameres is similar to *E. apiculatus* sp. nov., but the species can be separated by the processes on segment nine.

Ecnomus veratus sp. nov.

Figures 7, 8, 9

Type material. Holotype male, Northern Territory, Groote Eylandt, Amagule Pool, 6 Feb 1984, M. Davies (NMV, T-10039).

Paratypes. 3 males (specimen CT-056 figured), collected with holotype (NMV).

Other material examined. Western Australia. 2 males, Morgan R., Theda H.S., Kimberleys, 28 Sep 1979, J.B.; 1 male, Camp Ck at crusher, Mitchell Plateau, 15 Feb 1979, J.E.B.; 1 male, Mitchell Plateau, 30 Jan 1978, J.E.B; 1 male, stream opposite Deadhorse Gap, L Argyle, 19 Feb 1977, J.E.B.

Northern Territory. 1 male, South Alligator R., UDP Falls, 7 Sep 1979, J.B.; 3 males, ARRS South Alligator R. below BHP camp, 25 May 1988, P.S., A.W.; 3 males, ARRS South Alligator R. at Gimbat OSS Station, 24 May 1988, A.W., P.S.; 2 males, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, A.W., P.S.; 1 male, Jim Jim Waterhole, Kakadu Nat. Pk, 5 Sep 1979, J.B.; 3 males, Kambolgie Ck, 25 May 1988, P.S., A.W.; 5 males, Gulungul Ck, inlet to Gulungul Billabong, 20 Apr 1989, A.W., P.S.; 9 males, ARRS Radon Springs, 18–19 May 1988, A.W., P.S.; 5 males, same loc., 13–14 Apr 1989, A.W., P.S.; 1 male, Nourlangie Ck, 6 km E of Mt Cahill, 12°52′S, 132°46′E, 18 Nov 1972, J.C. Cardale (ANIC); 1 male, Nourlangie Ck, 8 km E of Mt Cahill, 12°52′S, 132°47′E, 14–15 Jun 1973, J.C. Cardale (ANIC); 1 male, Stag Ck at BHP camp, 25 May 1988, P.S., A.W.; 3 males, ARRS Magela Ck at Ranger Pipe outlet, 20 May 1988, A.W., P.S.; 1 male, same loc., 25 May 1988, A.W., P.S.; 2 males, Magela Ck, N of Georgetown Billabong, 24 Mar 1983, A.J. Sharley (NTM); 1 male, same loc., 28 Mar 1983, A.J. Sharley (NTM); 1 male, Georgetown Billabong nr Jabiru, 27 Jun 1983, A.J. Sharley (NTM); 1 male, same loc., 1 Jul 1983, A.J. Sharley (NTM); 1 male, Goanna Lagoon, 1 km W of Jabiru, off Arnhem Hwy, 27 Feb 1979, R. Marchant; 1 male, same loc., 27 Mar 1980, R. Marchant; 1 male, ARRS Ck 5 km W of OSS Gimbat Field Station, 19 Apr 1989, A.W., P.S.; 1 male, ARRS Bowerbird Billabong outlet, 1 Oct 1988, P. Dostine; 1 male, Graveside Ck, 18 Jul 1988, P. Dostine; 2 males, Muirella Park, 12 Oct 1972, E.R. Rick (ANIC); 2 males, Caranbirini Waterhole, 13 km SW of Borroloola, 16°16′S, 136°05′E, 3 Nov 1975, J.C. Cardale (ANIC).

Queensland. 1 male, Marina Plains via Musgrave, 10 May 1983, Storey and Brown; 1 male, Hann R. crossing, 76 km N Laura, 8 Sep 1974, M.S. Moulds.

Description. Male. Wings pale fawn to brown, wing venation (Fig. 9), characteristic of all other Australian species in the genus. In forewing, footstalk of fork R1 slightly shorter than in *E. volsellus* sp. nov. Genitalia with superior appendage in lateral view, broadest in basal half, tapered distally (Fig. 7). Inferior appendage in ventral view, length about 3× width, inner margin convex, tapered distally, apex constricted laterally (Fig. 8) and dilated dorso-ventrally, producing a spatulate appearance. In lateral view, single paramere with enlarged base, in distal half greatly elongated and strongly downturned; phallus dilated subapically forming a bulbous head, small apical point ventrally directed (Fig. 7).

Female. Unknown.

Length of anterior wing: male 3.7–4.2 mm.

Etymology. Veratus (Latin) armed with a javelin (paramere).

Distribution. N-WA (Kimberley region), N-NT, NE-Qld (Fig. 111).

Remarks. A unique Australian species due to the male possessing a single, greatly elongated paramere and a distinctive phallus. *E. veratus* is a widespread species across northern Australia.

Ecnomus turgidus Neboiss

Figures 10, 11, 97, 98

Ecnomus turgidus Neboiss, 1982: 289, fig. 20. — Neboiss, 1986: 151.

Type material. Holotype male, Western Australia, Serpentine River below Serpentine Falls, 20 Sep 1978, A. Neboiss (NMV, T-6194). Type seen.

Paratypes. 35 males, 35 females (specimens CT-026 male, CT-113 female figured), collected with holotype (ANIC, BM, NMV, WAM). Type material was examined and new figures drawn from the paratypes.

Other material examined. Western Australia. (localities published by Neboiss, 1982).

South Australia. 10 males, Murray R., Wombat Flat Billabong, S of Morgan, 19 Jan 1983, A.W.

Victoria. 48 males, Wyperfield Nat. Pk, L Werrebean, 6 Apr 1977, J.B.; 1 male, Wimmera R. upstream Horsham, 18 Nov 1985, Invertebrate Studies Unit RWC; 21 males, Royal Botanic Gardens, *Nymphaea* lily lake, 15 Mar 1986, K.L. Walker; 1 male, Yarra R., Burnley Plant Research Inst., 15 Nov 1976; 1 male, Bobs Pond Causeway, 5 km W of Emerald, 23 Aug 1980, D. Cartwright; 1 male, Sugarloaf Res., 28 Nov 1984, J. Dean; 2 males, same loc., 13 Jan 1986, D. Cartwright; 2 males, same loc., 20 Jan 1986, D. Cartwright; 1 male, Tyers R. on Yallourn North–Tyers Rd, 38°8.9′S, 146°27′E, 12 Nov 1980, Latrobe C Survey; 1 male, ITR/ Morwell R. jn, LRES site 8, 22 Feb 1974; 1 male, Traralgon Ck, Traralgon, 13 Feb 1973; 1 male, GGS Timbertop nr Merrijig, 30 Nov 1957, J. Landy; 1 male, same loc., 20 Dec 1957, Edwards; 2 males, Ovens R., Porepunkah, 1 Dec 1979, A.W., Bailey; 1 male, 10 km NW of Eskdale, 4 Nov 1976, A.A. Calder.

New South Wales and ACT. 1 male, Murrumbidgee R., Balranald, 34°38′S, 143°34′E, 6 Jan 1982, G. Bennison; 1 male, Lees Ck, Brindabella Range, ACT, 26 Nov 1977, G. Daniels.

Queensland. 1 male, South Pine R., 8 km W of Samford, 21 Oct 1980, A.N.; 1 male, Gregory R. crossing nr Goodwood, 24 Aug 1977, K.J. Lambkin; 1 male, Eungella Nat. Pk, Broken R. at camping ground, 24 Apr 1979, A.W.

Northern Territory. 3 males, Todd R., 9 km NE of Alice Springs, 23°38′S, 133°53′E, 28 Sep 1978, J.C. Cardale (ANIC).

Description (revised after Neboiss, 1982). Wings fawn to brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view broadbased, length about 2× maximum width, tapered strongly distally, a digitiform projection present on ventral margin near base (Fig. 10). Inferior appendage in ventral view, length about 2.5× width, tapered distally (Fig. 11), with a slender dorsally-directed, digitiform projection at apex. In lateral view, paramere slender, gradually depressed distally; phallus produced into a short projection (Fig. 10).

Female. Genitalia (Figs 97, 98): ventral plate subquadrate with small lateral-facing "pocket" formed by overhang, situated near baso-mesal angle. Ventral plate slightly concave immediately lateral and distal to "pocket".

Length of anterior wing: male 4.3–6.0 mm, female 4.7–6.5 mm.

Distribution. S-WA, SE-SA, Vic., NSW, E-Qld, S-NT (Fig. 110).

Remarks. A widespread species throughout the southern half of Australia. The male ressembles *E. digrutus* sp. nov., in the shape of the superior and inferior appendages, but can be separated by small differences in all genitalic characters.

Ecnomus digrutus sp. nov.

Figures 12, 13

Type material. Holotype male, Western Australia, Fine Springs Ck on road between L Argyle Tourist Village and Duncan Hwy, 23 Feb 1977, J.E. Bishop (NMV, T-10043).

Paratypes. 2 males (specimen CT-067 figured), collected with holotype (NMV).

Other material examined. Western Australia. 2 males, Camp Ck, Mitchell Plateau, 31 Jan 1978, J.E.B.; 1 male, Mitchell Plateau, 30 Jan 1978, J.E.B.

Northern Territory. 2 males, ARRS Radon Springs, 13–14 Apr 1988, A.W., P.S.

Description. Male. Wings pale reddish-brown. Genitalia in lateral view with superior appendage broadbased, tapered strongly distally, maximum width in distal third about 1/6 maximum width in basal third, a slender digitiform projection present on ventral margin near base (Fig. 12). Inferior appendage in ventral view, length about 3× width, inner margin with two shallow excisions, one in basal half, second in distal 1/4 (Fig. 13), with a subapical, dorsally-directed digitiform projection. In lateral view, paramere slender, apex slightly dilated; phallus produced into a slender point (Fig. 12).

Female. Unknown.

Length of anterior wing: male 3.6–3.8 mm.

Etymology. Digrutus – anagram of turgidus.

Distribution. N-WA (Kimberley region), N-NT (Fig. 112).

Remarks. The male is similar to *E. turgidus* in having projections on both the superior and inferior appendages, but differs in the shape. *E. digrutus* is a rare northern Australian species.

Ecnomus woronan sp. nov.

Figures 14, 15

Type material. Holotype male, Western Australia, Camp Ck at crusher, Mitchell Plateau, 15 Feb 1979, J.E. Bishop (NMV, T-10046).

Paratypes. 8 males (specimen CT-078 figured), collected with holotype (NMV).

Other material examined. Western Australia. 1 male, Mitchell Plateau, 30 Jan 1978, J.E.B.; 1 male, same loc., 14 Feb 1979, J.E.B.; 3 males, Fine Springs Ck on rd between L Argyle Tourist Village and Duncan Hwy, 23 Feb 1977, J.E.B.; 1 male, Fine Springs Ck, 2 Feb 1978, J.E.B.

Northern Territory. 1 male, Devil Devil Ck, 70 km SW of Daly R. Mission, 23 Aug 1979, J.B.; 3 males, South Alligator R., UDP Falls, 7 Sep 1979, J.B.; 1 male, South Alligator R. nr Koolpin Crossing, 14 Oct 1987, P. Dostine; 2 males, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, A.W., P.S.; 2 males, same loc., 19–20 Apr 1989, P.S., A.W.; 2 males, ARRS South Alligator R. at Gimbat OSS Station, 24 May 1988, A.W., P.S.; 2 males, ARRS South Alligator R. below BHP camp, 25 May 1988, P.S., A.W.; 1 male, ARRS South Alligator R. below Fisher Ck jn, 24 May 1988, A.W., P.S.; 3 males, SAR site 1, various dates 1988, P. Dostine; 2 males, ARRS Radon Springs, 18–19 May 1988, P.S., A.W.; 1 male, Graveside Ck, 18 Jul 1988, P. Dostine; 2 males, Graveside Gorge, 18 Jul 1988, P. Dostine; 1 male, ARRS Bowerbird Billabong outlet, 1 Oct 1988, P. Dostine; 3 males, ARRS Ck 5 km W of OSS Gimbat Field Station, 19 Apr 1989, A.W., P.S.; 2 males, SAR, Rock Hole Ck, November 1988, P. Dostine; 2 males, Gulungul Ck inlet to Gulungul Billabong, 20 Apr 1989, A.W., P.S.; 1 male, ARRS Kambolgie Ck, 25–26 May 1988, A.W., P.S.; 6 males, same loc., 25 May 1988, A.W., P.S.; 1 male, Goanna Lagoon, 1 km W of Jabiru off Arnhem Hwy, 28 Jan 1980, R. Marchant; 1 male, 16 km NE of Mt Cahill, 12°50′S, 132°51′E, 13 Jun 1973, J.C. Cardale (ANIC).

Queensland. 2 males, Crystal Ck, Mt Spec turnoff, 2 May 1979, A.W.

Description. Male. Wings pale fawn to brown. Genitalia with superior appendage in lateral view, length about 3× width, tapered slightly distally (Fig. 14). Inferior appendage in ventral view, short and robust, length about 2× width, apex rounded, with a broadbased mesal projection at about the middle and a second projection subapically (Fig. 15). In lateral view, paramere short, robust; phallus obliquely narrowed subapically (Fig. 14).

Female. Unknown.

Length of anterior wing: male 3.3–4.0 mm.

Etymology. Named after the Woronan language of the aboriginal tribe who inhabited the region around the type locality.

Distribution. N-WA (Kimberley region), N-NT, NE-Qld (Fig. 114).

Remarks. The basic form of the inferior appendages is similar to *E. kakaduensis* sp. nov., and *E. tridigitus* sp. nov., but the shape differs. Two male specimens have been collected from Mt Spec, NE-Queensland which differ from the type material in the shape of the inferior appendages. The mesal projections are less prominent (Fig. 15a). The form of other genitalic structures agree with the type specimen (Fig. 14a). There is also one male specimen from the Mitchell Plateau in N-Western Australia (specimen CT-064), which although slightly damaged, is similar to the Mt Spec specimens.

Ecnomus kakaduensis sp. nov.

Figures 16, 17

Type material. Holotype male, Northern Territory, Radon Ck, Kakadu Nat. Pk, 3 Sep 1979, J. Blyth (NMV, T-10055).

Paratypes. 2 males (specimen CT-066 figured), collected with holotype (NMV).

Other material examined. Northern Territory. 1 male, 16 km NE of Mt Cahill, 12°50′S, 132°51′E, 13 Jun 1973, J.C. Cardale (ANIC); 1 male, Graveside Ck, 18 Jul 1988, P. Dostine; 3 males, ARRS Graveside Gorge, 18 Jul 1988, P. Dostine.

Western Australia. 1 male, Camp Ck, Mitchell Plateau, 13 Jul 1978, P.S.; 1 male, same loc., 20 Jul 1978, P.S.; 1 male, trib. Camp Ck, Mitchell Plateau, 19 Jul 1978, P.S.

Description. Male. Wings fawn to brown. Genitalia with superior appendage in lateral view, broadest in basal half, tapered gradually distally (Fig. 16). Inferior appendage in ventral view, rounded apically, length about 3× width, with mesal digitiform projections medially and subapically (Fig. 17). In lateral view, paramere gradually depressed distally, apex truncated (Fig. 16). Phallus obliquely narrowed distally, slightly dorso-ventrally compressed (Figs 16, 17).

Female. Unknown.

Length of anterior wing: male 3.8–4.1 mm.

Etymology. Named after the type locality (Kakadu National Park).

Distribution. N-NT, N-WA (Kimberley region) (Fig. 113).

Remarks. The form of the inferior appendages is similar to *E. woronan* and *E. tridigitus* sp. nov., but *E. kakaduensis* differs slightly in shape. The species is uncommonly recorded from northern Australia.

Ecnomus wellsae sp. nov.

Figures 18, 19, 101, 102

Type material. Holotype male, New South Wales, Severn River, 29°28.3′S, 151°29′E, 23 Oct 1981, Wells and Carter (NMV, T-10058).

Paratypes. 10 males, 1 female (specimens CT-017 male, CT-097 female figured), collected with holotype (NMV).

Other material examined. New South Wales. 1 male, Wilson R., NW Wauchope, 31°14′S, 152°34′E, 30 Oct 1981, A.W., Carter.

Queensland. 1 male, Cunninghams Gap, 3 Dec 1982, G. Theischinger; 5 male, Booloumba Ck, 8 km SW Kenilworth, 26°39′S, 152°39′E, 12 Dec 1984, G. Theischinger; 1 male, same loc., 12 Jan 1986, G. Theischinger; 1 male, Mothar Mt, 12 km SE Gympie, 29 Oct 1980, A.N.; 1 male, Granite Ck, 210 m, Bulburin State Forest via Many Peaks, 1 Apr 1972, S.R. Monteith (ANIC); 3 males, Cathay Ck, Eungella, 25 Apr 1979, A.W.; 2 males, Broken R., Eungella Range, Mackay rainforest, 9 Jun 1971 (QM); 3 males, Upper Ross R., below weir SW of Townsville, 8 May 979, A.W.; 6 males, Alice R., Hervey Range Rd, 25 km W of Townsville, 9 May 1979, A.W.; 1 male, Millstream Falls, W of Ravenshoe, 25 Jun 1971, E.F. Riek (ANIC).

Description. Wings brown to dark greyish-brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view long, stout, tapered slightly distally, with downwardly produced basiventral angle (Fig. 18). Inferior appendage in ventral view, with basal half broad, two small mesal projections, one medial and the second positioned distally (Fig. 19). In lateral view, paramere robust, gradually depressed distally, with truncated apex; phallus with shallow ventral subapical swelling (Fig. 18), but with obvious spine embedded in ventral surface subapically (Fig. 19).

Female. Genitalia (Figs 101, 102): ventral plate with obvious notch in distal margin, with slender elongate, lateral-facing "pocket" near mid-mesal margin formed by an overhang, ventral plate deeply concave lateral to "pocket".

Length of anterior wing: male 4.3–6.3 mm, female 6.1 mm.

Etymology. Named for Dr Alice Wells (collector).

Distribution. NE-NSW, E-Qld (Fig. 113).

Remarks. The male can be readily identified by the triangular shape of the inferior appendages. The female can be distinguished by the long, slender "pockets".

Ecnomus tridigitus sp. nov.

Figures 20, 21, 91, 92

Type material. Holotype male, New South Wales, Bellinger River, 30°26′S, 152°44′E, 31 Oct 1981, Wells and Carter (NMV, T-10070).

Paratypes. 12 males, 1 female (specimens CT-012 ♂, CT-099 ♀ figured), collected with holotype (NMV).

Other material examined. New South Wales. 1 male, Coxs R. on Coxs R. Rd, 10 km S of Lithgow, 4 Nov 1981, A.W., Carter; 1 male, Allyn R., NE of Ecclestone, 3 Nov 1981, A.W., Carter; 41 males, Boyd R., 5 km E of Dalmerton on Old Grafton Rd, 27 Oct 1981, A.W., Carter; 34 males, Styx R. Forest camp in Styx R. State Forest, 28 Oct 1981, A.W., Carter.

Queensland. 4 males, Obi Obi Ck, 8 km SW of Mapleton, 23 Oct 1980, A.N.; 2 males, Yabba Ck, 10 km W of Imbil, 26 Oct 1980, A.N.; many males, Glastonbury Ck, 15 km W of Gympie, 27 Oct 1980, A.N.; 1 male, Emu Ck State Forest nr Benarkin, 26°53′S, 152°08′E, 15 Jan 1986, G. Theischinger.

Description. Wings brown to dark greyish-brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view long, broadest in median section, narrowed in distal 1/4, apex inclined downwards, ventral margin weakly serrate (Fig. 20). Inferior appendage in ventral view, length about 3× width, with two subapical projections and apex produced into a digitiform process (Fig. 21). In lateral view, paramere robust, straight distally; phallus without ventral subapical swelling (Fig. 20), with a pair of large curved spines embedded in ventral surface subapically (Fig. 20).

Female. Genitalia (Figs 91, 92): ventral plate with outside margin rounded, tapered distally, with rounded distal-facing "pocket" near mesal margin in basal third, formed by an overhang.

Length of anterior wing: male 4.1–5.2 mm, female 5.2 mm.

Etymology. Tridigitus (Latin) three fingers (inferior appendage).

Distribution. E-NSW, SE-Qld (Fig. 111).

Remarks. In the male, the structure of the inferior appendages is similar to *E. woronan* and *E. kakaduensis*, but can be distinguished by the distinctive narrowing of the superior appendages.

Ecnomus neboissi sp. nov.

Figures 22, 23

Type material. Holotype male, Victoria, Genoa River near Wangarabell, 18 Mar 1977, A. Neboiss (NMV, T-10084, figured specimen CT-031).

Other material examined. Queensland. 1 male, Girraween Nat. Pk nr Wyberba, 10 Oct 1973, A.N.

Description. Male. Wings greyish-brown with paler irrorations. Genitalia with superior appendage in lateral view long, length about 4× width, ventral margin weakly crenulate (Fig. 22), in ventro-lateral view basiventral angle is downwardly and mesally produced into a broad projection (Fig. 22a). Inferior appendage in ventral view robust, length about 2× width, with two subapical projections and apex produced into a digitiform process (Fig. 23). In lateral view,

paramere broad, gradually depressed distally, apex dilated and curved downwards at right angles to form a distinct hook; phallus obliquely narrowed subapically (Fig. 22), with two short spines embedded in ventral surface (Fig. 23).

Female. Unknown.

Length of anterior wing: male 5.6–5.7 mm.

Etymology. Named after Dr Arturs Neboiss (collector).

Distribution. E-Vic., SE-Qld (Fig. 111).

Remarks. E. neboissi can be readily identified by the distinctive form of the inferior appendages. Only two specimens are known and have been collected from widely separated localities.

Ecnomus turrbal sp. nov.

Figures 24, 25

Type material. Holotype male, Queensland, Brisbane River nr Kholo, 9 Mar 1973, M.H. Colbo (NMV, T-10085).

Paratypes. 5 males (specimen CT-041 figured), collected with holotype (NMV).

Other material examined. Queensland. 1 male, Brisbane R., Kholo, 12 Oct 1972, M.H. Colbo; 1 male, Kenmore nr Brisbane, 8 Jan 1977, G. Daniels; 3 males, Glastonbury Ck, 15 km W of Gympie, 27 Oct 1980, A.N.; 4 males, Paluma Dam, 12-13 May 1980, I.D. Naumann, J.C. Cardale (ANIC); 35 males, Upper Ross R. below weir SW of Townsville, 8 May 1979, A.W.; 3 males, Alice R., Hervey Range Rd, 25 km W Townsville, 9 May 1979, A.W.; 1 male, Stoney Ck on Mt Stuart Rd, Townsville, 27 Apr 1979, A.W.; 1 male, Tinaroo Pines Caravan Park, 9 Apr 1972, N. McFarland; 8 males, Tinaroo Dam, November 1982, G. Theischinger; 3 males, Downfall Ck, Tinaroo Falls Dam, 22 May 1980, I.D. Naumann, J.C. Cardale (ANIC).

Northern Territory. 3 males, Adelaide R., 15 km E of Mt Stuart Hwy, 15 Aug 1979, J.B.; 17 males, ARRS Kambolgie Ck, 25 May 1988, P.S., A.W.

Description. Male. Wings fawn to brown. Genitalia with superior appendage in lateral view broader in basal half, tapered distally with slightly dilated apex (Fig. 24). Inferior appendage in ventral view, length about 4× width, apex with two-pronged or bifid appearance (Fig. 25), in lateral view broad in median section, length about 2× width; paramere robust, gradually depressed distally, apex slightly dilated, curved downwards to form a hook; phallus without a distinct ventral subapical swelling (Fig. 24).

Female. Unknown.

Length of anterior wing: male 4.0–5.0 mm.

Etymology. Named after the Turrbal aboriginal tribe who inhabited the region encompassing the type locality.

Distribution. E-Qld, N-NT (Fig. 111).

Remarks. The male is similar to *E. cuspidis* sp. nov. and *E. bishopi* sp. nov. in having inferior appendages broad in lateral view. The bifid apices of the inferior appendages in *E. turrbal* are diagnostic.

Ecnomus cuspidis sp. nov.

Figures 26, 27

Type material. Holotype male, Queensland, Upper Ross River below weir, SW of Townsville, 8 May 1979, A. Wells (NMV, T-10091).

Paratypes. 2 males (specimen CT-073 figured), collected with holotype (NMV).

Other material examined. Western Australia. 2 males, Ord R. below dam, 21 Feb 1977, J.E.B.; 1 male, Spillway Ck, 2 Feb 1978, J.E.B.; 1 male, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 1 male, stream opposite Deadhorse Gap, L Argyle, 19 Feb 1977, J.E.B.; 6 males, Granite Ck, Kununurra–L Argyle Hwy, 2 Feb 1978, J.E.B.

Northern Territory. 1 male, Daly Waters, 15 May 1976, Carnaby; 3 males, Howard Springs, 9 Sep 1980, D. King; 2 males, Jim Jim Ck on Kakadu Hwy, 28 May 1988, A.W., P.S.; 5 males, Magela Ck, various sites, dates and collectors; 8 males, ARRS Ranger Mine, RP1 and RP2, various dates and collectors; 1 male, Georgetown Billabong nr Jabiru, 13 Jul 1983, A.J. Sharley; 6 males, Goanna Lagoon, 1 km W of Jabiru off Arnhem Hwy, various dates 25 Apr 1979–30 Aug 1979, R. Marchant; 1 male, Coonjimba Billabong, 19 May 1988, P.S., A.W.; 4 males, ARRS Gulungul Ck, inlet to Gulungul Billabong, various dates, A.W., P.S.; 1 male, 5 km NNW of Cahills Crossing (E Alligator R.), 12°23′S, 132°57′E, 8–9 Jun 1973, J.C. Cardale (ANIC); 2 males, ARRS E Alligator R. at Cahills Crossing, 27 May 1988, A.W., P.S.; 1 male, 36 km SW of Borroloola, 16°19′S, 136°05′E, 4 Nov 1975, J.C. Cardale (ANIC).

Queensland. 2 males, swamp 28 km N Laura, 30 Nov 1974, Moulds; 4 males, Tinaroo Dam, Nov 1982, G. Theischinger; 3 males, Tinaroo Dam (nr Kairi Ck), 22 Jun 1971, E.F. Riek (ANIC); 1 male, Tinaroo Pines Caravan Pk, 9 Apr 1972, N. McFarland; 1 male, Downfall Ck, Tinaroo Falls Dam, 22 May 1980, I.D. Naumann, J.C. Cardale (ANIC); 1 male, Glastonbury Ck, 15 km W of Gympie, 27 Oct 1980, A.N.; 1 male, Clintonvale, 14 Oct 1973, A.N.; 1 male, Brisbane R., Kholo, 9 Mar 1973, M.H. Colbo; 1 male, Cunninghams Gap, Western Fall, 28°03′S, 152°24′E, 1 Dec 1984, G. Theischinger.

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view long, stout, length about 3× width (Fig. 26). Inferior

appendage in ventral view, length about 3× width, narrowed slightly in median section, inflected distally, with a dorso-mesally directed digitiform projection apically (Fig. 27), in lateral view broad medially, length about 2× width, sub-trapezoidal in shape, proximal angle of upper margin obtuse, apical projection visible above dorsal margin; paramere with apex turned downwards at right angles to form a distinct hook as in *E. bishopi* sp. nov.; phallus obliquely narrowed subapically (Fig. 26).

Female. Unknown.

Length of anterior wing: male 3.6–4.9 mm.

Etymology. *Cuspidis* (Latin) point (inferior appendages).

Distribution. N-WA (Kimberley region), N-NT, E-Qld (Fig. 115).

Remarks. A slightly variable species, very similar to *E. bishopi* sp. nov., and very difficult to distinguish from it. The sub-trapezoidal shape of the inferior appendage in lateral view, is consistent and different to the trigonal shape in *E. bishopi* sp. nov.

There is slight variation in the shape of the inferior appendage between several larger specimens collected from SE-Queensland and the type material. In the SE-Queensland specimens (Figs 26a, 27a), the inferior appendage in ventral view, length is about 4× width, the distal margin is produced into a swelling (Fig. 27a), in lateral view the apical projection appears to arise from the inferior appendage below the level of the dorsal margin (Fig. 26a), whereas in the type specimens it arises at the level of the dorsal margin (Fig. 26). Only four specimens of the atypical SE-Queensland form have been collected, therefore all specimens are referred to *E. cuspidis* for the present.

Ecnomus bishopi sp. nov.

Figures 28, 29

Type material. Holotype male, Western Australia, Spillway Ck, Ord River Dam, 20 Feb 1977, J.E. Bishop (NMV, T-10095).

Paratypes. 1 male (figured specimen CT-079), collected with holotype; 1 male, same loc., 2 Feb 1978, J.E. Bishop; 1 male, Ord River, 9 km N Kununurra, 19 Sep 1978, J. Blyth (NMV).

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view, length about 2.5× width, broadest in basal half, narrowed slightly in median section (Fig. 28). Inferior appendage in ventral view, length about 4× width, narrowed slightly in middle, inflected distally, with a mesally-directed digitiform process apically (Fig. 29), in lateral view broad, length about 2× width, trigonal in shape, proximal angle of upper margin nearly a right angle, apical projection only just visible above dorsal margin; paramere with apex turned downwards at right angles to form a distinct hook; phallus obliquely narrowed subapically (Fig. 28), as in *E. cuspidis.*

Female unknown.

Length of anterior wing: male 3.7–3.8 mm.

Etymology. Named after Dr J.E. Bishop (collector).

Distribution. N-WA (Kimberley region) (Fig. 115).

Remarks. The male is very similar to *E. cuspidis.* In *E. bishopi* the inferior appendage in lateral view is trigonal in shape, whereas in *E. cuspidis* it is sub-trapezoidal. A rare species as only four males have been collected from two sites.

Ecnomus clavatus sp. nov.

Figures 30, 31

Type material. Holotype male, Northern Territory, Lambells Lagoon, Humpty Doo, 19 Aug 1979, J. Blyth (NMV, T-10096).

Paratypes. 13 males (specimen CT-043 figured), collected with holotype (NMV).

Other material examined. Western Australia. 1 male, Wittenoom Gorge, 5 km S of Wittenoom, 26 Oct 1979, J.B.; 2 males, Millstream, Fortescue R., S of Roebourne, 12 Nov 1978, M.S. and B.J. Moulds; 1 male, Lockyer Gorge, Harding R., Pilbara, 19 Oct 1979, J.B.; 1 male, Gieki Gorge Nat. Pk, 9 Oct 1979, J.B.; 11 males, Mitchell Plateau, various sites, dates and collectors; 1 male, Granite Ck, L Argyle–Kununurra Hwy, 2 Feb 1978, J.E.B.; 5 males, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 6 males, stream opposite Deadhorse Gap, L Argyle, 19 Feb 1977, J.E.B.; 6 males, Ord R. below dam, 21 Feb 1977, J.E.B.; 5 males, Spillway Ck, 2 Feb 1978, J.E.B.; 1 male, Fine Springs Ck on rd between L. Argyle Tourist Village and Duncan Hwy, 23 Feb 1977, J.E.B.; 4 males, Four Mile Ck, 2 Feb 1978, J.E.B.

Northern Territory. 1 male, Jasper Ck, Victoria River Downs Rd, 45 km SSE Timber Ck, 17 Sep 1979, J. Blyth; 32 males, many tribs of S and E Alligator Rivers, Kakadu Nat. Pk, 17–26 May 1988, A.W., P.S.; 1 male, Graveside Gorge, 18 Jul 1988, P. Dostine; 1 male, Nourlangie Ck, 8 km N of Mt Cahill, 12°48′S, 132°42′E, 16–17 Jun 1973, J.C. Cardale (ANIC); 1 male, Nourlangie Ck, 6 km E of Mt Cahill, 12°52′S, 132°46′E, 18 Nov 1972, J.C. Cardale (ANIC); 1 male, Magela Ck, S of Georgetown Billabong, 28 Mar 1983, A.J. Sharley; 6 males, Georgetown Billabong nr Jabiru, various dates 9 Oct 1982–3 Jul 1983, A.J. Sharley; 2 males, Goanna Lagoon, 1 km W Jabiru off Arnhem

Hwy, 25 Apr 1979, R. Marchant; 2 males, same loc., 27 Jun 1979, R. Marchant; 1 male, Cooper Ck, 19 km SE of Mt Borradaile, 9 Nov 1973, D.H. Colless (ANIC).

Queensland. 1 male, Coen R., Coen, 31 Oct 1988, K. Walker; 1 male, Stoney Ck on Mt Stuart Rd, Stuart, Townsville, 27 Apr 1979, A.W.; 1 male, Ross R. at Apex Pk nr Townsville, 11 Apr 1979, A.W.; 1 male, same loc., 26 Apr 1979, A.W.; 9 males, Upper Ross R. below weir, SW of Townsville, 8 May 1979, A.W.; 1 male, Brisbane R. nr Kholo, 9 Mar 1973, M.H. Colbo.

Description. Male. Wings pale fawn to light brown. Genitalia with superior appendage in lateral view broader in basal half, tapered gradually distally (Fig. 30). Inferior appendage longer than superior appendage, long and slender, in ventral view length about 5× width, slightly constricted in median section, with short triangular mesal projection in basal third (Fig. 31). In lateral view, paramere gradually depressed with truncate apex; phallus lacking ventral subapical swelling, with upper apical angle extended into a short point (Fig. 30).

Female. Unknown.

Length of anterior wing: male 3.2–5.0 mm.

Etymology. Clavatus (Latin) club shaped (inferior appendages).

Distribution. N-WA, N-NT, E-Qld (Fig. 116).

Remarks. E. clavatus is a widespread northern Australian species distinguished by the long and slender form of the inferior appendages.

Ecnomus deani sp. nov.

Figures 32, 33, 99, 100

Type material. Holotype male, Victoria, Little River, 6 km E of Wulgulmerang, 12 Dec 1976, A. Neboiss (NMV, T-10110).

Paratypes. 6 males (specimen CT-013 figured), collected with holotype (NMV).

Other material examined. Victoria. Many males from many sites in eastern Victoria.

New South Wales. 2 males, Tianjana Falls, NW of Ulladulla, 35°07′S, 153°20′E, 10 Jan 1985, G. Theischinger; 2 males, Crackenback R. nr Thredbo, 14 Feb 1975, T. Petr; 1 male, Thredbo R. at Thredbo, 5–7 Jan 1984, P. Teislyer; 18 males, 1 female (CT-110 female figured), Mt Kosciusko, 21 Feb 1969, A.N.; 3 males, same loc., 2100 m, small trickle, 5 Jan 1984, G. Theischinger; 1 male, same loc., 1500m, 9 Jan 1982, G. Theischinger; 1 male, Diggers Ck, Mt Kosciusko Rd, 13 Feb 1975, T. Petr; 7 males, Perisher Ck nr Perisher, 13 Feb 1975, T. Petr; 1 male, Jindabyne, 21 Feb 1969, A.N.; 1 male, 1 female, Snowy R., 8 Feb 1966, E.F. Riek (ANIC); 1 male, Wragges Ck, 10 Feb 1966, E.F. Riek (ANIC); 1 male, 3 females, Monga, 6 Feb 1966, E.F. Riek (ANIC); 11 males, 14 females, Brown Mt, 18 Jan 1961, E.F. Riek (ANIC); 2 males, Dilgry R., 19 km NW Rawdon Vale, 31°53′S, 151°32′E, 18 Feb 1980, A.A. Calder; 11 males, Upper Manning R., 20 km NNW Rawdon Vale, 31°52′S, 151°34′E, 19 Feb 1980, A.A. Calder; 7 males, 13 km W of Dorrigo, 22 Feb 1966, E.F. Riek (ANIC); 13 males, Styx R., 12 km S of Ebor, 17 Oct 1973, A.N.; 1 male, Poverty Point, Tenterfield, 22 Feb 1979, E. Dahms (QM).

Description. Wings light brown-darker greyish brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view stout, with downwardly produced basiventral angle (Fig. 32). Inferior appendage in ventral view with basal half broad, a mesal projection medially, apex (Fig. 33), not drawn out as far as in *E. tillyardi*. In lateral view, paramere robust with apex dilated and curved downwards to form a distinct hook; phallus (Fig. 32), similar to *E. tillyardi*.

Female. Genitalia (Figs 99, 100); ventral plate with small lateral-facing "pocket" near mesal margin in basal 1/4, formed by overhang; surface of plate slightly concave immediately lateral and distal to "pocket".

Length of anterior wing: male 5.0–7.7 mm, female 8.3–8.6 mm.

Etymology. Named after Mr John Dean.

Distribution. E-Vic., E-NSW (Fig. 113).

Remarks. The inferior appendages of the male are distinctive, although similar in form to *E. tillyardi* and *E. volsellus* sp. nov. A smaller atypical specimen (CT-036), collected from the Wentworth R., Victoria is partly figured (Figs 32a, 33a). The superior appendage in lateral view, has a downwardly produced basiventral angle extended into an obvious projection (Fig. 32a). The inferior appendage in ventral view (Fig. 33a), is less tapered in the distal half than in the type specimens. The female description and figures are based on a specimen (CT-110), collected from Mt Kosciusko, New South Wales. *E. deani* is, at present, the only species collected from higher altitudes. The female is not included in the type material as it was not collected from near the type locality.

Ecnomus tillyardi Mosely

Figures 34a, 35a, 103, 104

Ecnomus tillyardi Mosely in Mosely and Kimmins, 1953: 378, fig. 260. — Jacquemart, 1965: 29. — Neboiss, 1977: 55, figs 243–249. — Neboiss, 1986: 150.

Type material. Holotype male, Tasmania, Cradle Mt, 22 Jan 1917, J.W. Evans (BMNH). Type not seen.

Other material examined. Tasmania. Many males and females including specimens from localities additional to those published by Neboiss, 1977.

South Australia. 1 male, Mosquito Ck, S of Naracoorte Hwy bridge, 22 Nov 1977, P.S.

Victoria. 5 males, 1 female, Stokes R., 8 km N of Dartmoor, 23 Nov 1977, P.S.; 5 males, Wando R., Wando Dale Station, 30 Oct 1977, A.W., P.S.; 1 male, Pigeon Ponds Ck, Nareen, 30 Oct 1977, A.W., P.S.; 4 males, 2 females, L Purrumbete, 23 Feb 1970, E.F.Riek (ANIC); 4 males, 1 female, same loc., 12 Nov 1976, A.N.; 7 males, Gellibrand R., 3 km E of Gellibrand, 26 Jan 1982, A.N., R. StClair; 54 males, Gellibrand R. at Asplin Ck jn, 28 Jan 1982, A.N.; 1 male, Clearwater Ck, 5 km S of Beech Forest, Otways, 3 Jan 1975, L.M.; 8 males, 9 females, Yarrowee R., 2 km W of Inverleigh, 2 Mar 1978, A.N.; 9 males, 2 females, Moorabool R., Meridith, 12 Feb 1959, A.N.; 1 male, Moorabool R., Durdidwarrah Rd, 25 Mar 1953, A.N.; 15 males, Ballan, 4 Nov 1953, A.N.; 4 males 1 female, Clunes, 6 Jan 1956, A.N.; 1 male, Newlyn Res., 25 Nov 1969, E.F. Riek (ANIC); 35 males, 26 females, Coliban R., 6 km SW Kyneton, 18 Feb 1973, A.N.; 1 male, Sunbury, 18 Dec 1953, A.N.; 3 males, Jacksons Ck, 8 km N of Sunbury, 25 Nov 1952, A.N.; 6 males, 2 females, Jacksons Ck, Clarkefield, 18 Dec 1953, A.N.; 2 males, 4 females, Plenty R., Sth Morang, 29 Dec 1953, A.N.; 2 males, 3 females, Kangaroo Ground, 18 Dec 1954, A.N.; many males and females, Yarra R., sites between Tarrawarra and nr McMahons Ck jn, various dates 17 Feb 1976–14 Feb 1981, A.N.; 3 males, Woori Yallock Ck, Woori Yallock, 16 Jan 1974, A.N.; many males and females, recorded from streams in eastern Victoria, list of localities from author.

New South Wales. 5 males, Boyd R., 29°50′S, 152°21′E, 11 Feb 1988, G. Theischinger.

Description (revised after Mosely and Kimmins, 1953; Neboiss, 1977). Wings dark greyish-brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view long, with downwardly produced basiventral angle (Fig. 34a). Inferior appendage in ventral view with basal half broad, mesal projection medial, distal half straight, laterally compressed (Fig. 35a), in lateral view apex slightly dilated; paramere robust with apex curved downwards to form a hook; phallus narrowed subapically with a short apical process (Fig. 34a).

Female. Genitalia (Figs 103, 104): ventral plate long, similar to *E. volsellus* sp. nov., with elongate lateral-facing "pocket" near mesal margin in distal half, formed by overhang, plate deeply concave lateral of "pocket", distal margin bluntly pointed.

Length of anterior wing: male 5.9–7.3 mm, female 6.5–8.5 mm.

Distribution. Tas., SE-SA, Vic., NE-NSW (Fig. 117).

Remarks. E. tillyardi is a large, variable species with genitalia similar in form to *E. volsellus* sp. nov. and *E. deani*. The male differs in the shape of the apex of the inferior appendage especially in lateral view. The form of the genitalia is very uniform in Tasmanian males. Twelve male specimens have been collected from SE-South Australia and western Victoria (Fig. 34c), which are very similar to Tasmanian specimens in the shape of the inferior appendage. In males collected progressively further east, the distal half of the inferior appendage tends to be more slender and the apex more upturned (Figs 34d–f, b). The paramere also changes correspondingly from the bulbous, straight form found in Tasmanian specimens to the more slender, hooked shape in eastern Victorian ones (Fig. 34b). Hence there appears to be a cline extending for about 450 km across Victoria (Fig. 117). In eastern Victorian female specimens (Figs 103a, 104a), the "pockets" on the ventral plate are more slender than in Tasmanian specimens (Figs 103, 104). Future work may prove otherwise, but for the present all SE-South Australian, Victorian and New South Wales variants are placed in *E. tillyardi*. The only example of male and female *Ecnomus* preserved in copula has been collected from the Yarra River and is illustrated to show the "key in lock" pairing formed during copulation (Figs 107, 108).

Ecnomus volsellus sp. nov.

Figures 36, 37, 38, 105, 106

Type material. Holotype male, Victoria, Genoa River nr Wangarabell, 18 Mar 1977, A. Neboiss (NMV, T-10142).

Paratypes. 20 males (specimen CT-014 figured), collected with holotype; 1 female (specimen CT-092 figured), Victoria, Tambo Crossing, 24 Jan 1960, A. Neboiss (NMV).

Other material examined. Victoria. Many males collected from numerous localities in eastern Victoria.

New South Wales. 3 males, Mumbulla Ck, 15 km NE Bega, 19 Mar 1979; 5 males, McLaughlin R. nr Ando, 20 Nov 1965, A.N.; 5 males, 3 females, same loc., 4 Nov 1966, E.F. Riek (ANIC); 13 males, Hacking R., Royal Nat. Pk nr Sydney, 2 Oct 1985, A.N.; 22 males, Coxs R. on Coxs R. Rd, 10 km S of Lithgow, 4 Nov 1981, A.W., Carter; 1 male, Molong, 29 Dec 1973, M.S. Moulds; 2 males, Blandford, 8 Dec 1976, Moulds; 2 males, Upper Allyn R., 12 km N of Eccleston, 21 Feb 1980, A.A. Calder; 3 males, Terania Ck, N of Lismore, 28°25′S, 153°18′E, 21 Jan 1986, G. Theischinger; 1 male, Styx R. at forest camp, Styx R. State

Forest, 28 Oct 1981, A.W., Carter; 3 males, 3 females, Gara R., 20 Feb 1966, E.F. Rick (ANIC); 1 male, Wilson R., NW Wauchope, 31°14′S, 152°34′E, 30 Oct 1981, A.W., Carter; 60 males, Apsley R. at falls, SE of Walcha, 29 Oct 1981, A.W., Carter; 1 male, Blue Hole, Gyra R., 30°36′S, 151°48′E, 7 Feb 1987, G. Theischinger; 6 males, 3 females, Bakers Ck Falls nr Armidale, 30°35′S, 151°54′E, 6 Feb 1987, G. Theischinger; 17 males, Boonoo Boonoo R., 5 km upstream falls, 11 Oct 1973, A.N.; 2 males, same loc., 29 Nov 1981, G. Daniels, M.A. Schneider (ANIC).

Queensland. 11 males, Cunninghams Gap, Western Fall, 28°03′S, 152°24′E, 1 Dec 1984, G. Theischinger; 2 males, Girraween Nat. Pk nr Wyberba, 10 Oct 1973, A.N.; 2 males, Fletcher, 14 km SSW of Stanthorpe, 16 Jan 1969, E. Dahms (QM); 2 males, same loc., 30 Mar 1971, E. Dahms (QM); 4 males, 2 females, Goomburra State Forest, NE of Warwick, 28°03′S, 152°07′E, 20 Jan 1986, G. Theischinger; 1 male, Mt Tamborine, 8 Jan 1975, M.S. Moulds.

Description. Wings brown to darker greyish-brown with paler irrorations, wing venation similar to other Australian species. In forewing (Fig. 38), footstalk of fork R1 longer than in *E. veratus*.

Male. Genitalia with superior appendage long, in lateral view straight, with downwardly produced basiventral angle (Fig. 36). Inferior appendage in ventral view with basal half broad, mesal projection at the middle, distal half tapered apically, inflexed (Fig. 37), and directed slightly dorsally. In lateral view, paramere robust, with apex curved downwards to form a hook; phallus (Fig. 36), similar to *E. tillyardi*.

Female. Genitalia (Figs 105, 106): ventral plate similar in form to *E. tillyardi*, long with elongate, lateral-facing "pocket" near mesal margin in distal half, formed by overhang, plate deeply concave lateral to "pocket", distal margin rounded.

Length of anterior wing: male 5.7–7.7 mm, female 7.4 mm.

Etymology. Volsellus (Latin) pincers (inferior appendages).

Distribution. E-Vic., E-NSW, SE-Qld (Fig. 112).

Remarks. E. volsellus is a large species which can be grouped with *E. tillyardi*. In the male the long, inflexed inferior appendages are distinctive.

Ecnomus pansus Neboiss

Figures 39, 40, 87, 88

Ecnomus pansus Neboiss, 1982: 288, figs 21–23. — Neboiss, 1986: 150.

A male, identified and figured as *E. continentalis* Ulmer by Mosely and Kimmins (1953: 380, fig. 261), should be referred to this species.

Type material. Holotype male, Western Australia, Frankland River, Circular Pool, 6 km NE of Walpole, 27 Nov 1978, A. Neboiss (NMV, T-6165).

Paratypes. 35 males, 8 females (specimen CT-027 male figured), collected with holotype (ANIC, BM, NMV, WAM). Type material was examined and new figures drawn from paratype male.

Other material examined. The list of localities is available from the author.

Description (revised after Neboiss, 1982). Wings pale fawn to light brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view long and narrow, length about 6× width, apex slightly dilated (Fig. 39). Inferior appendage in ventral view, length about 2.5× width, apex pointed, slightly inflected, with a subapical digitiform mesal projection at about distal third (Fig. 40). In lateral view, paramere broadbased, slender and gradually depressed in distal half; phallus obliquely narrowed with a long projection apically (Fig. 39).

Female. Genitalia (Figs 87, 88): ventral plate with small rounded "pocket" or pit near mesobasal angle, inserted into the surface of the plate, which is slightly concave particularly in mesodistal area.

Length of anterior wing: male 4.2–6.0 mm, female 5.0–7.0 mm.

Distribution. S-WA, SA, Vic., NSW, Qld, NT (Fig. 114).

Remarks. E. pansus is a common and widespread species, where the male is easily identified by the long, slender superior appendages.

Ecnomus cygnitus Neboiss

Figures 41, 42, 89, 90

Ecnomus cygnitus Neboiss 1982: 288, figs 18, 19. — Neboiss 1986: 150.

Type material. Holotype male, Victoria, Swan Lake, 30 km NW of Portland, 27 Feb 1976, P.A. Meyer (NMV, T-6670). Type seen.

Other material examined. South Australia. (localities published by Neboiss, 1982).

Victoria. 5 males, 1 female (specimen CT-096 female figured), Wannon R., Nigretta Falls, 6 Dec 1983, A.N.; 17 males (specimen CT-025 figured), L. Fyans, E of Grampians, 15 Mar 1973, A.N.; numerous males, from many lakes, reservoirs and streams (list of localities from author).

Tasmania. 5 males, West Bay R., Margate, 6 Jan 1977, A.N., P. Allbrook; 7 males, L. Fiddler, Lower

Gordon R., 13 Dec 1977, D. Coleman; 1 male, Carlton R., Carlton, 26 Dec 1975, M. Davies; 1 male, Scots Peak dam, Serpentine Impoundment, 23 Mar 1985, Greenslade and Rounsevell; 1 male, L. Pedder, site J, December 1977, P.S. Lake.

New South Wales. 1 male, Khancoban Pondage, 14 Feb 1975, T. Petr; 1 male, Towamba R. nr Kiah, 11 Feb 1975, T. Petr; 1 male, Severn R., 29°28.3′S, 151°29′E, 23 Oct 1981, A.W., Carter.

Queensland. 1 male, Manchester Dam Spillway, N of Ipswich, 1 Feb 1973, M.H. Colbo; 1 male, Gregory R. crossing nr Goodwood, 24 Aug 1977, K.J. Lambkin.

Description (revised after Neboiss, 1982). Wings fawn-pale brown with paler irrorations.

Male. Genitalia with superior appendage in lateral view long, stout, length about 3× width, slightly narrowed from about middle (Fig. 41). Inferior appendage in ventral view, length about 3x width, with a subapical mesal projection at about the middle separated widely from the apical angle (Fig. 42). In lateral view, paramere broadbased, slender and slightly depressed in distal half; phallus obliquely narrowed subapically (Fig. 41).

Female. Genitalia (Figs 89, 90): ventral plate, form similar to *E. pansus*, with rounded "pocket" or pit near meso-basal angle, inserted into the surface of the plate which is slightly concave especially in meso-distal area.

Length of anterior wing: male 4.0–6.5 mm, female 7.1 mm.

Distribution. SE-SA, Tas., Vic., E-NSW, E-Qld (Fig. 116).

Remarks. This species is common, widespread and slightly variable. There is some variation particularly in the shape of the inferior appendages of the male, throughout the distribution range. In Queensland and northern New South Wales specimens (Fig. 42a; Neboiss, 1978: figs 10, 11), the inferior appendage in ventral view is robust, length about twice width, the distal outer margin is produced into a noticeable swelling, and the distance between the mesal subapical projection and the apical angle is about equal to the depth of the concavity between them i.e. the concavity is relatively deep. In Tasmanian specimens (Fig. 42b; Neboiss, 1977: figs 255, 256), the inferior appendage in ventral view is more slender, length about 3× width, the distal outer margin is smoothly rounded, and the distance between the mesal subapical projection and the apical angle is about 3× the depth of the concavity between them i.e. the concavity is relatively shallow. The SE-South Australian, Victorian and SE-New South Wales specimens are intermediate in these characters. Only a few specimens have been collected of the SE-Queensland, NE-New South Wales and Tasmanian variants, hence all specimens are referred to *E. cygnitus* for the present.

Ecnomus kerema sp. nov.

Figures 43, 44

Type material. Holotype male, Queensland, Yuccabine Ck, Kirrama State Forest, 18°12′S, 145°54′E, February 1986, R. Pearson and L. Benson (NMV, T-10164, figured specimen CT-103).

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view with downwardly directed basiventral angle produced into broad swelling, length about 3× width (Fig. 43). Inferior appendage in ventral view, length about 2.5× width, with digitiform mesal projection situated close to the apex (Fig. 44). In lateral view, paramere with apex elongate, curved downwards at right angles to form a pronounced hook; phallus obliquely narrowed (Fig. 43), similar to *E. continentalis*.

Female. Unknown.

Length of anterior wing: male 4.2 mm.

Etymology. Named after the Kerema aboriginal tribe who inhabited the region including the type locality.

Distribution. NE-Qld (known only from type locality) (Fig. 118).

Remarks. This species is known from only one male specimen which is similar to *E. continentalis*, especially in the shape of the inferior appendages, but differs significantly in the shape of the parameres.

Ecnomus continentalis Ulmer

Figures 45, 46, 93, 94

Ecnomus continentalis Ulmer, 1916: 10, figs 12–14. — Mosely and Kimmins, 1953: 380, fig. 261. — Neboiss, 1977: 56, figs 255, 256. — Neboiss, 1978: 830, figs 10, 11. — Neboiss, 1982: 286, figs 16, 17. — Neboiss, 1986: 150.

A male specimen from South Australia, identified and figured as *E. continentalis* by Mosely and Kimmins (1953), should be referred to *E. pansus*.

Specimens PT-458 (Tasmania) and PT-557 (SE-Queensland), identified and figured as *E. continentalis* by Neboiss (1977, 1978) should be referred to *E. cygnitus*.

Type material. Lectotype male (designated by Neboiss, 1982), Queensland, Malanda, date unknown, Mjöberg (NRS). Type not seen.

Lectoparatypes 3 males, same locality (NRS).

Other material examined. Northern Territory, 2 males, Reedy Rockhole, George Gill Range, 24°22′S, 131°45′E, 30 Dec 1986, J.A. Davis. Remaining list of localities available from author.

Description (revised after Neboiss, 1982). Wings light brown to dark greyish-brown with paler irrorations.

Male. Genitalia with superior appendage long, in lateral view stout, length about 3× width, with downwardly produced basiventral angle (Fig. 45). Inferior appendage short, robust, in ventral view length about 1.5× width, with mesal digitiform projection situated close to the apex (Figs 46, 46a). In lateral view, paramere with apex curved downwards at right angles to form a distinct hook; phallus obliquely narrowed subapically, with a short process apically (Fig. 45).

Female. Genitalia (Figs 93, 94): ventral plate with small lateral-facing "pocket" near mesal margin in basal third, formed by overhang. Surface of plate concave disto-laterally of "pocket". Margin of plate with obvious notch in disto-lateral corner.

Length of anterior wing: male 5.0–6.7 mm, female 5.4 mm.

Distribution. SE-SA, Vic., E-NSW, E-Qld, S-NT (Fig. 118).

Remarks. E. continentalis is a very common and widespread species. The male is similar to *E. kerema* but differs slightly in the form of the inferior appendages and parameres.

Ecnomus nibbor sp. nov.

Figures 47, 48, 95, 96

Type material. Holotype male, Victoria, Mitchell River near Tabberabbera, 30 Dec 1975, collector unknown (NMV, T-10165).

Paratypes. 3 males (specimen CT-016 figured), collected with holotype; 1 female (specimen CT-104 figured), Victoria, Little River, 6 km E of Wulgulmerang, 12 Dec 1976, A. Neboiss (NMV).

Other material examined. Victoria. 3 males, Wellington R., 23 km NNE of Licola on Tamboritha Rd, 25 Feb 1978, NMV Survey Dept; 1 male, Wellington R., 17 km N of Licola, 14 Feb 1977, A.A. Calder; 2 males, Macalister–Barkly R. jn, Lyndon Flat, 6 Dec 1977, NMV Survey Dept; 2 males, jn Macalister–Wellington Rivers, 23 Feb 1978, NMV Survey Dept; 1 male, Wellington–Carey R. jn, 15 Feb 1977, A.A. Calder; 1 male, Mitchell R. nr Tabberabbera, 21 Jan 1976, collector unknown; 1 pharate male, trib. Cann R., Noorinbee North, 21 May 1981, J. Dean, D. Cartwright; 4 males, Genoa R. at Wangarabell, 8 Feb 1980, A.W.

New South Wales. 1 male, Upper Allyn R., 12 km N of Eccleston, 21 Feb 1980, A.A. Calder; 2 males, Gloucester R., 9 km SW of Gloucester, 17 Feb 1980, A.A. Calder; 2 males, Wilson R., NW of Wauchope, 31°14′S, 152°34′E, 30 Oct 1981, A.W., Carter.

Description. Wings fawn-light brown with paler irrorations.

Male. Genitalia with superior appendage long, in lateral view stout, tapered slightly apically (Fig. 47). Inferior appendage in ventral view robust, length about 2× width, with a small subapical mesal projection at about distal 1/4 (Fig. 48). In lateral view, paramere with apex curved downwards at right angles to form a distinct hook; phallus with a laterally compressed process apically (Fig. 47).

Female. Genitalia (Figs 95, 96): ventral plate with lateral-facing "pocket" near mesal margin at middle, formed by overhang. Surface of plate concave just disto-laterally of "pocket".

Length of anterior wing: male 4.5–5.8 mm, female 8.2 mm.

Etymology. Named after the aboriginal word for the Mitchell R. near the type locality – *nibbor.*

Distribution. E-Vic., NE-NSW (Fig. 119).

Remarks. The male shows some similarities to *E. karakoi* sp. nov., especially in the form of the inferior appendages, but can be distinguished by differences in the phallus and parameres.

Ecnomus ancisus sp. nov.

Figures 49, 50

Type material. Holotype male, Western Australia, Ord River below dam, 21 Feb 1977, J.E. Bishop (NMV, T-10170).

Paratypes. 2 males (specimen CT-051 figured), collected with holotype (NMV).

Other material examined. Western Australia. 1 male, Spillway Ck, Ord R. Dam, 20 Feb 1977, J.E.B.; 1 male, Spillway Ck, 2 Feb 1978, J.E.B.; 1 male, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 1 male, Four Mile Ck, 2 Feb 1978, J.E.B.; 2 males, Camp Ck at crusher, Mitchell Plateau, 15 Feb 1979, J.E.B.; 1 male, Mitchell Plateau, mining camp, 14°49′S, 125°50′E, 9–19 May 1983, Naumann, Cardale (ANIC); 1 male, Mitchell Plateau, Surveyor Rd, 17 Jul 1978, P.S.; 1 male, Morgan Falls, 15°02′S, 126°40′E, 16–17 Aug 1975, I.F.B. Common, M.S. Upton (ANIC); 1 male, Maggie Ck, 90 km Kununurra–Wyndham, 3 Feb 1978, J.E.B.; 1 male, Charnley R., 16°22′S, 125°12′E, 2 km SW Rolly Hill, 16–20 Jun 1988, I.D. Naumann (ANIC).

Northern Territory. 1 male, Mataranka, 14 Jul 1969, C. Le Souef; 1 male, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, P.S., A.W.; 2 males, SAR site 1, 14 Jun 1988, P. Dostine; 4 males, same loc., 30 Sep 1988, P. Dostine; 2 males, same loc., Octo-

ber 1988, P. Dostine; 1 male, ARRS Graveside Gorge, 18 Jul 1988, P. Dostine.

Description. Male. Wings pale reddish-fawn. Genitalia with superior appendage in lateral view broadest in basal half, constricted strongly in distal third, with dilated apex (Fig. 49). Inferior appendage in ventral view, length about 3× width, broadest in basal half, before tapering to pointed apex (Fig. 50). In lateral view, paramere moderately slender, depressed distally; phallus with upper apical angle extended to a slender point. Meso-ventral process on segment ten long (Fig. 49).

Female. Unknown.

Length of anterior wing: male 3.9–4.3 mm.

Etymology. Ancisus (Latin) cut away (superior appendage).

Distribution. N-WA (Kimberley region), N-NT (Fig. 118).

Remarks. The male is easily identified by the distinctive shape of the superior appendages.

Ecnomus blythi sp. nov.

Figures 51, 52

Type material. Holotype male, Northern Territory, Jasper Ck, Victoria River Downs Rd, 45 km SSE Timber Ck, 17 Sep 1979, J. Blyth (NMV, T-10173).

Paratypes. 2 males (specimen CT-057 figured), collected with holotype (NMV).

Other material examined. Northern Territory. 2 males, Cooper Ck, 19 km SE of Mt Borradaile, 12°06′S, 133°04′E, 9–10 Nov 1972, J.C. Cardale (ANIC); 1 male, same loc., 5–6 Jun 1973, J.C. Cardale (ANIC); 1 male, Goanna Lagoon, 1 km W of Jabiru off Arnhem Hwy, 27 Jun 1979, R. Marchant; 1 male, same loc., 25 Apr 1979, R. Marchant; 1 male, South Alligator R. below BHP camp, 25 May 1988, P.S., A.W.; 1 male, Nourlangie Ck, 12 Apr 1989, A.W., P.S.; 6 males, ARRS Kambolgie Ck, 25 May 1988, A.W., P.S.; 1 male, Jim Jim Ck on Kakadu Hwy, 28 May 1988, P.S., A.W.; 3 males, Gulungul Ck, inlet to Gulungul Billabong, 20 Apr 1989, A.W., P.S.; 2 males, same loc., 11 Apr 1989, A.W., P.S.; 10 males, Muirella Park, 12 Oct 1972, E.F. Riek (ANIC); 1 male, Katherine Gorge, 23 May 1970, J.A.L. Watson (ANIC); 2 males, same loc., 13 Aug 1979, J.B.

Western Australia. 1 male, Ord R. below dam, 21 Feb 1977, J.E.B.; 1 male, Granite Ck, Kununurra–L Argyle Hwy, 2 Feb 1978, J.E.B.; 1 male, Stonewall Ck, 4 Feb 1978, J.E.B.; 3 males, Morgan R., Theda H.S., Kimberleys, 28 Sep 1979, J.B.; 1 male, Kimberley, 6.5 km NW Mt Bell, 17°10′S, 125°17′E, 25–26 Jul 1988, T.F. Houston (WAM).

Description. Male. Wings pale reddish-fawn. Genitalia with superior appendage in lateral view broadest in basal half, constricted strongly in middle section, maximum width in distal third about 1/4 maximum width in basal half (Fig. 51). Inferior appendage in ventral view, length about 3× width, with concave inner margin, apex rounded, inflected (Fig. 52), and dorsoventrally flattened. In lateral view, paramere constricted subapically before "hammerhead"-shaped apex; phallus lacking ventral subapical swelling. Meso-ventral process on segment ten long (Fig. 51).

Female. Unknown.

Length of anterior wing: male 3.3–4.1 mm.

Etymology. Named after Mr J. Blyth (collector).

Distribution. N-NT, N-WA (Kimberley region) (Fig. 119).

Remarks. The male is identified by the distinctive narrowing of the superior appendages.

Ecnomus centralis sp. nov.

Figures 53, 54

Type material. Holotype male, South Australia, Scrubby Ck Waterhole, 27°40′S, 140°18′E, 8 Nov 1983, M. Thompson (NMV, T-10176).

Paratypes. 1 male, collected with holotype (genitalia slightly damaged); 1 male (specimen CT-038 figured), Queensland, Diamantina River, Birdsville, 13 May 1975, J. Blyth (NMV).

Other material examined. South Australia. 2 males, 72 km S of Birdsville, Andrewillah Waterhole, 21 May 1975, J.B.; 3 males, Innaminka Crossing, 11 Oct 1987, M. Drewien; 1 male, Maroocutchanie Lake, 10 Oct 1987, M. Drewien.

New South Wales. 1 male, Darling R., Bourke, 8 May 1975, J.B.

Northern Territory. 2 males, Anthonys Lagoon, 16 May 1976, Carnaby; 1 male, Newcastle Waters, 10 km W of Elliot, 10 Aug 1979, J.B.

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view broad-based, tapered gradually distally (Fig. 53). Inferior appendage in ventral view long and slender, with slightly inflected apex extended further than apex of superior appendage (Fig. 54), in lateral view with subapical dorsal digitiform projection in distal quarter. In lateral view, paramere slightly depressed distally with small lateral flange near apex; phallus laterally compressed, lacking ventral subapical swelling (Fig. 53).

Female. Unknown.

Length of anterior wing: male 3.7–4.8 mm.

Etymology. Centralis (Latin) central or middle (central Australian distribution).

Distribution. NE-SA, NW-NSW, SW-Qld, S-NT (Fig. 116).

Remarks. The species is recorded from central Australia and is distinguished by the form of the inferior appendages.

Ecnomus myallensis sp. nov.

Figures 55, 56, 85, 86

Type material. Holotype male, Queensland, Myall Ck, 3 km N of Rangemore, S of Bunya Mountains, 15 Oct 1973, A. Neboiss (NMV, T-10179).

Paratypes. 2 males (specimen CT-042 figured), collected with holotype (NMV).

Other material examined. Victoria. 1 male, 1 female (specimen CT-087 female figured), Greenvale Reservoir, ornamental ponds, 24 Feb 1983, D. Cartwright.

Description. Wings light brown with paler irrorations.

Male. Genitalia with superior appendage long, in lateral view stout, length about 3× width, broadest in basal half (Fig. 55), basiventral angle produced into a mesally directed digitiform projection (Fig. 55a). Inferior appendage in lateral view long, narrowed near middle before broadening distally, apex laterally compressed (Figs 55, 56), with small digitiform projection in basal half. In lateral view, paramere robust, gradually depressed and tapered distally; phallus lacking ventral subapical swelling, upper margin produced into a short projection (Fig. 55).

Female. Genitalia (Figs 85, 86): ventral plate lacking "pocket", with central round concave area and obvious ridge near baso-mesal margin. Notch present in outer distal margin.

Length of anterior wing: male 5.1–5.2 mm, female 5.8 mm.

Etymology. Named after type locality (Myall Ck).

Distribution. SE-Qld, C-Vic. (Fig. 116).

Remarks. Five specimens of *E. myallensis* are known, collected from two widely separated localities. The male is distinguished by the form of the inferior appendages. The female description and figures are taken from a specimen (CT-087) collected from Victoria where the male and female have been associated by breeding through from the larva. The female is not included in the type material as it is not from near the type locality.

Ecnomus yabbura sp. nov.

Figures 57, 58

Type material. Holotype male, Western Australia, Morgan River, Theda H.S., Kimberleys, 28 Sep 1979, J. Blyth (NMV, T-10182).

Paratype. 1 male (specimen CT-060 figured), collected with holotype (NMV).

Other material examined. Western Australia. 1 male, Barnett R. Gorge, Barnett Station, Kimberleys, 1 Oct 1979, J.B.; 2 males, Drysdale R., 15°02′S, 126°55′E, 3–8 Aug 1975, I.F.B. Common, M.S. Upton (ANIC); 1 male, Camp Ck at crusher, Mitchell Plateau, 15 Feb 1979, J.E.B.; 1 male, Mitchell Plateau, mining camp, 14°49′S, 125°50′E, 9–19 May 1983, Naumann, Cardale (ANIC); 1 male, Granite Ck, L Argyle–Kununurra Hwy, 2 Feb 1978, J.E.B.

Northern Territory. 1 male, South Alligator R., UDP Falls, 7 Sep 1979, J.B.; 2 males, ARRS South Alligator R. at Gimbat OSS Station, 28 Apr 1988, P. Dostine; 2 males, SAR, site 1, 14 Jun 1988, P. Dostine; 2 males, same loc., 30 Sep 1988, P. Dostine; 1 male, same loc., October 1988, P. Dostine; 4 males, ARRS Bowerbird Billabong outlet, 1 Oct 1988, P. Dostine; 4 males, ARRS Ck 5 km W of OSS Gimbat Field Station, 19 Apr 1989, A.W., P.S.; 2 males, Graveside Ck, 18 Jul 1988, P. Dostine; 2 males, Caranbirini Waterhole, 13 km SW Borroloola, 16°16′S, 136°05′E, 3 Nov 1975, J.C. Cardale (ANIC).

Description. Male. Wings pale fawn-light brown. Genitalia with superior appendage long, in lateral view length about 2× width, broadbased, tapered distally. Inferior appendage in lateral view, long and slender, extending beyond apex of superior appendage (Fig. 57), in ventral view broadest in basal half, narrowed in middle before slightly dilated apex, apex dorsoventrally flattened producing a spatulate appearance (Fig. 58). In lateral view, paramere elongate, broadbased, slender in distal half; phallus obliquely narrowed subapically. Processes of segment ten robust, situated between the bases of the superior appendages (Fig. 57).

Female. Unknown.

Length of anterior wing: male 3.3–4.0 mm.

Etymology. Named after a Western Australian aboriginal word for north–*yabbura* (distribution).

Distribution. N-WA (Kimberley region), N-NT (Fig. 119).

Remarks. The male is identified by the distinctive and long inferior appendages.

Ecnomus miriwud sp. nov.

Figures 59, 60

Type material. Holotype male, Western Australia, Spillway Ck, 2 Feb 1978, J.E. Bishop (NMV, T-10184).

Paratypes 15 males (specimen CT-068 figured), collected with holotype (NMV).

Other material examined. Western Australia, 8 males, Spillway Ck, Ord R. Dam, 20 Feb 1977, J.E.B.; 2 males, same loc., 2 Feb 1978, J.E.B.; 2 males, Ord R. at Kununurra Dam, 22 Feb 1977, J.E.B.; 3 males, Ord R. below dam, 21 Feb 1977, J.E.B.; 6 males, Ord R., 9 km N of Kununurra, 19 Sep 1979, J.B.; 1 male, Fine Springs Ck, 2 Feb 1978, J.E.B.; 8 males, Granite Ck, Kununurra–L Argyle Hwy, 2 Feb 1978, J.E.B.; 3 males, Four Mile Ck, 2 Feb 1978, J.E.B.; 1 male, Stonewall Ck, 4 Feb 1978, J.E.B.; 1 male, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 1 male, stream opposite Deadhorse Gap, L Argyle, 19 Feb 1977, J.E.B.; 1 male, Carson R., 8 km NE of Theda Station, Kimberleys, 1 Oct 1979, J.B.; 1 male, Barnett R. Gorge, Barnett Station, Kimberleys, 1 Oct 1979, J.B.; 1 male, Charnley R., 16°22′S, 125°12′E, 2 km SW Rolly Hill, 16–20 Jun 1988, I.D. Naumann (ANIC).

Northern Territory, 1 male, Katherine R. Gorge Nat. Pk, 13 Aug 1979, J.B.; 1 male, South Alligator R., Coronation Hill, upper site, 4–5 Jun 1988, P. Cranston; 12 males, SAR site 1, various dates 1988, P. Dostine; 2 males, ARRS South Alligator R. below Fisher Ck jn, 24 May 1988, A.W., P.S.; 3 males, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, A.W., P.S.; 2 males, same loc., 19–20 Apr 1989, P.S., A.W.; 4 males, South Alligator R. nr Koolpin Crossing, 14 Oct 1987, P. Dostine; 1 male, ARRS Ck 5 km W of OSS Gimbat Field Station, 19 Apr 1989, A.W., P.S.; 4 males, Bowerbird Billabong outlet, 1 Oct 1988, P. Dostine; 4 males, ARRS South Alligator R. at Gimbat OSS Field Station, 24 May 1988, A.W., P.S.; 3 males, ARRS Kambolgie Ck, 25 May 1988, A.W., P.S.; 1 male, Bessie Springs, 8 km ESE of Cape Crawford, 16°40′S, 135°51′E, 26 Oct 1975, J.C. Cardale (ANIC); 1 male, 12 km NNE of Borroloola, 15°58′S, 136°21′E, 1 Nov 1975, J.C. Cardale (ANIC); 1 male, McArthur R., 48 km SSW of Borroloola, 16°27′S, 136°05′E, 29 Oct 1975, J.C. Cardale (ANIC); 2 males, 36 km SW of Borroloola, 16°19′S, 136°05′E, 4 Nov 1975, J.C. Cardale (ANIC); 2 males, Surprise Ck, 45 km SSW of Borroloola, 16°25′S, 136°05′E, 5 Nov 1975, J.C. Cardale (ANIC); 19 males, McArthur R., 16°47′S, 135°45′E, 14 km SW of Cape Crawford, 25 Oct 1975, J.C. Cardale (ANIC); 4 males, 14 km NW of Cape Crawford, 16 34′S, 135 41′E, 6 Nov 1975, J.C. Cardale (ANIC).

Queensland, 1 male, Hann R. Crossing, 76 km N of Laura, 8 Sep 1974, M.S. Moulds.

Description. Male. Wings pale fawn. Genitalia with superior appendage short, in lateral view broadbased, length about 1.5× width, tapered strongly distally, mesal spines extend about halfway along upper margin (Fig. 59). Inferior appendage short, in ventral view length about 3× width, slightly inflected distally (Fig. 60). In lateral view, paramere long and slender; phallus lacking ventral subapical swelling (Fig. 59).

Female. Unknown.

Length of anterior wing: male 3.1–3.6 mm.

Etymology. Named after the Miriwud aboriginal tribe who inhabited the region including the type locality.

Distribution. N-WA (Kimberley region), N-NT, NE-Qld (Fig. 113).

Remarks. A small species, similar to *E. kitabal* and *E. larakia* sp. nov., in the shape of the superior and inferior appendages, but can be separated by the extension of the mesal spines along upper margin of the superior appendages.

Ecnomus wagengugurra sp. nov.

Figures 61, 62

Type material. Holotype male, New South Wales, Clarence River at Yates Crossing, 26 Oct 1981, Wells and Carter (NMV, T-10200).

Paratype, 1 male (figured specimen CT-062), collected with holotype (NMV).

Other material examined. Queensland, 1 male, Davies Ck nr Mareeba, 27 Oct 1988, K. Walker; 3 males, Annan R., 3 km SW of Black Mt, 15°41′S, 145°12′E, 27 Sep 1980, J.C. Cardale (ANIC); 1 male, same loc., 26–27 Apr 1981, I.D. Naumann (ANIC).

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view broadest in basal half, tapered slightly distally (Fig. 61). Inferior appendage in ventral view slender, length about 4× width, inner margin inflected towards base of apical point (Fig. 62), as in *E. walajandari* sp. nov. In lateral view, paramere long and slender; phallus obliquely narrowed subapically. Ventral processes of segment ten distinctive, long, apex divided into three lobes, each with an attached seta (Fig. 61).

Female. Unknown.

Length of anterior wing: male 4.1–4.5 mm.

Etymology. Named after the aboriginal word for the Clarence R. near the type locality – *wagengugarra.*

Distribution. NE-NSW, NE-Qld (Fig. 120).

Remarks. Only seven males have been recorded from three sites in two widely separated areas but the male can be identified by the distinctive shape of the processes on segment ten.

Ecnomus karawalla sp. nov.

Figures 63, 64

Type material. Holotype male, Victoria, Wannon River, Nigretta Falls, 6 Dec 1983, A. Neboiss (NMV, T-10202, figured specimen CT-032).

Description. Male. Wings brownish-grey. Genitalia with superior appendage long, in lateral view with downwardly produced basiventral angle (Fig. 63). Inferior appendage in ventral view robust, length about 2× width, broadest in basal half, terminating in pointed apex (Fig. 64). In lateral view, paramere robust; phallus lacking subapical ventral swelling, with a broad process apically (Fig. 63).

Female. Unknown.

Length of anterior wing: male 6.0 mm.

Etymology. Named after the aboriginal word for the Wannon R. near the type locality – *karawalla.*

Distribution. W-Vic. (known from type locality only) (Fig. 120).

Remarks. Although this species is known from only one male specimen, which is grouped with *E. russellius* and *E. karakoi* sp. nov. on the basis of the similar shape of the superior appendages and the dorso-ventrally flattened inferior appendages. It differs from both sufficiently to warrant description as a distinct species.

Ecnomus russellius Neboiss

Figures 65, 66, 83, 84

Ecnomus russellius Neboiss 1977: 56, figs 250–254. — Neboiss 1986: 150.

Type material. Holotype male, Tasmania, Russell Falls Nat. Pk, 20 Feb 1967, A. Neboiss (NMV, T-4854). Type seen.

Allotype female, collected with type (NMV, T-4855).

Paratypes. 4 males, 1 female, collected with holotype (NMV).

Other material examined. Tasmania. (localities additional to those published by Neboiss, 1977); 1 male (specimen CT-029 figured), Mersey R., Liena, 16 Nov 1972, A.N.; 1 female (specimen CT-108 figured), West Bay R., Margate, 6 Jan 1977, P. Allbrook, A.N.; 1 male, Great Musselroe R., Tebrakunna Rd, 7 Nov 1977, D. Coleman; 3 males, 3 females, Shannon R. at Wihareja, 29 Nov 1982, W. Fulton.

Victoria. numerous specimens from many streams, list of localities from author.

New South Wales. 5 males, McLauchlin R. nr Ando, 20 Nov 1965, A.N.; 3 males, 3 females, same loc., 4 Nov 1966, E.F. Riek (ANIC); 1 male, Dilgry R., 19 km NW Rawdon Vale, 31°53′S, 151°32′E, 18 Feb 1980, A.A. Calder; 3 males, Styx R., 12 km S of Ebor, 17 Oct 1973, A.N.; 1 male, Ebor Falls, 12 Nov 1983, G. Theischinger; 1 male, Terania Ck, N of Lismore, 28°25′S, 153°18′E, 21 Jan 1986, G. Theischinger.

Queensland. Many males, Cunninghams Gap, various dates, G. Theischinger; 1 male, Goomburra State Forest, NE of Warwick, 28°03′S, 152°07′E, 20 Jan 1986, G. Theischinger; 1 male, South Pine R., 8 km W of Sanford, 21 Oct 1980, A.N.; 2 males, Saddle Tree Ck via Maidenwell, 29 Mar 1975, S.R. Monteith (ANIC); 8 males, 2 females, Mt Superbus, 22–24 Jan 1971, S.R. Monteith (ANIC).

Description (revised after Neboiss, 1977). Wings light brown to dark greyish-brown with paler irrorations.

Male. Genitalia with superior appendage long, in lateral view with strong downwardly produced basiventral angle extended into a point (Fig. 65). Inferior appendage in ventral view broad, length about 2× width, narrowed in distal half (Fig. 66). In lateral view, paramere dilated distally with apex curved downwards at right angles to form a distinct hook; phallus tapered distally, with a distinctive laterally compressed process apically (Fig. 65).

Female. Genitalia (Figs 83, 84): ventral plate lacking "pocket" but with strong ridge along mesal margin in distal 2/3, terminating in pointed inner apical angle.

Length of anterior wing: male 5.5–8.5 mm, female 8.0–9.0 mm.

Distribution. Tas., Vic., E-NSW, SE-Qld (Fig. 119).

Remarks. This common species shows some similarities to *E. karawalla* and *E. karakoi* sp. nov., especially in the shape of the inferior appendages, but can be distinguished by small differences.

Ecnomus karakoi sp. nov.

Figures 67, 68

Type material. Holotype male, Victoria, Aire River, Otway Ranges, 6 Dec 1982, C. Yule (NMV, T-10203, figured specimen CT-030).

Description. Male. Wings greyish-brown. Genitalia with superior appendage long, in lateral view stout, with downwardly produced basiventral angle extended into a small projection (Fig. 67). Inferior appendage short, in ventral view robust, length about 2× width, with a subapical mesal projection at about distal third (Fig. 68). In lateral view, paramere with apex dilated and curved downwards to form a slight hook; phallus obliquely narrowed subapically, with a short process (Fig. 67).

Female. Unknown.

Length of anterior wing: male 7.2 mm.

Etymology. Named after the Karakoi aboriginal tribe, who inhabited the region including the type locality.

Distribution. SW-Vic. (Otway Ranges, known from type locality only) (Fig. 115).

Remarks. This is a large species known from only one male specimen, but it differs significantly in detail to warrant description as a distinct species. *E. karakoi* shows some similarities with *E. russellius, E. karawalla* and *E. nibbor* due to the similar shape of the superior appendages and the dorso-ventrally flattened inferior appendages, but differs in the detail of the inferior appendages.

Ecnomus tropicus sp. nov.

Figures 69, 70

Type material. Holotype male, Queensland, Upper Ross River below weir, SW of Townsville, 8 May 1979, A. Wells (NMV, T-10204).

Paratypes. 8 males (specimen CT-069 figured), collected with holotype (NMV).

Other material examined. Queensland. 1 male, Crystal Ck, Mt Spec turnoff, 2 May 1979, A.W.; 1 male, Alice R., Hervey Range Rd, 25 km W of Townsville, 9 May 1979, A.W.; 6 males, Laura, Cape York Peninsula, 7 Oct 1979, M.S. and B.J. Moulds; 1 male, swamp, 28 km N of Laura, 30 Nov 1974, Moulds; 1 male, Palmer R., 20 Jun 1971, E.F. Riek (ANIC); 7 males, Coen R., Coen, 31 Oct 1988, K. Walker.

Northern Territory. 2 males, Adelaide R., 15 km E of Stuart Hwy, 15 Aug 1979, J.B.; 1 male, South Alligator R., UDP Falls, 7 Sep 1979, J.B.; 1 male, ARRS South Alligator R. at Gimbat OSS Station, 24 May 1988, A.W., P.S.; 3 males, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, P.S., A.W.; 7 males, SAR site 1, various dates 1988, P. Dostine; 3 males, Jim Jim Ck on Kakadu Hwy, 28 May 1988, P.S., A.W.; 12 males, ARRS Kambolgie Ck, 25 May 1988, P.S., A.W.; 1 male, ARRS Radon Springs, 18–19 May 1988, P.S., A.W.; 1 male, ARRS Magela Ck, inlet to Mudginberri Billabong, 18 May 1988, P.S., A.W.; 4 males, Magela Ck at Ranger pipe outlet, 23 May 1988, P.S., A.W.; 1 male, Coonjimba Billabong, 19 May 1988, P.S., A.W.; 1 male, ARRS East Alligator R. at Cahills Crossing, 27 May 1988, A.W., P.S.

Western Australia. 1 male, Granite Ck, Kununurra Hwy, L Argyle, 2 Feb 1978, J.E.B.; 1 male, Spillway Ck, 2 Feb 1978, J.E.B.; 5 males, Morgan R., Theda H.S., Kimberleys, 28 Sep 1979, J.B.; 1 male, Drysdale R. headwaters, 30 km NW Mt Elizabeth H.S., 30 Sep 1979, J.B.; 1 male, Drysdale R., 14°39′S, 126°57′E, 18–21 Aug 1975, I. Common, M.S. Upton (ANIC); 1 male, Adcock Gorge, Gibb R.–Derby Rd, Kimberleys, 2 Oct 1979, J.B.; 1 male, Mitchell Plateau, crusher, 4 km SW mining camp, 14°52′S, 125°50′E, 2–6 Jun 1988, I.D. Naumann (ANIC).

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view broadest in basal half, tapered distally (Fig. 69). Inferior appendage in ventral view, almost parallel sided, length about 4× width, apex weakly bifid (Fig. 70), especially from ventro-lateral view (Fig. 69). In lateral view, paramere slender; phallus obliquely narrowed subapically (Fig. 69).

Female. Unknown.

Length of anterior wing: male 4.0–4.4 mm.

Etymology. Tropicus (Latin) tropic loving (northern distribution).

Distribution. NE-Qld, N-NT, N-WA (Kimberley region) (Fig. 120).

Remarks. The male is identified by the bifid apices on inferior appendages.

Ecnomus apiculatus sp. nov.

Figures 71, 72

Type material. Holotype male, Western Australia, Ord River, 9 km N Kununurra, 19 Sep 1979, J. Blyth (NMV, T-10213).

Paratypes. 6 males (specimen CT-018 figured), collected with holotype (NMV).

Other material examined. Western Australia. 3 males, Gieki Gorge Nat. Pk, 9 Oct 1979, J.B.; 1 male, Dunham R., W Kununurra, 22 Feb 1977, J.E.B.; 4 males, Spillway Ck, Ord R. Dam, 20 Feb 1977, J.E.B.; 3 males, same loc., 2 Feb 1978, J.E.B.; 14 males, Ord R. below dam, various dates, J.E.B.; 1 male, Fine Springs Ck, 2 Feb 1978, J.E.B.; 1 male, Stonewall Ck, 4 Feb 1978, J.E.B.; 8 males, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 5 males, stream opposite Deadhorse Gap, L Argyle, 19 Feb 1977, J.E.B.; 2 males, Granite Ck, Kununurra-L Argyle Hwy, 2 Feb 1978, J.E.B.; 6 males, 15 km S of Winjana Gorge, 4 Aug 1989, McCubbin.

Northern Territory. 12 males, 12 km NNE of Borroloola, 15°58′S, 136°21′E, 1 Nov 1975, J.C. Cardale (ANIC); 1 male, Batten Point, 15°54′S, 136°32′E, 30 km NE of Borroloola, 30 Oct 1975, J.C. Cardale (ANIC).

Queensland. 6 males (specimen CT-039 partly figured), Brisbane R. nr Kholo, 9 Mar 1973, M.H. Colbo.

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view broad-based, tapered gradually distally (Fig. 71). Inferior appendage in ventral view, length about 3× width, with a dorso-mesally directed digitiform process apically (Fig. 72), in lateral view, length about 3× width; paramere long, slender; phallus lacking ventral subapical swelling (Fig. 71).

Female. Unknown.

Length of anterior wing: male 3.0–4.3 mm.

Etymology. Apiculatus (Latin) small pointed (inferior appendages.)

Distribution. N-WA (Kimberley region), N-NT, SE-Qld (Fig. 117).

Remarks. This is a variable species. One specimen from N-Western Australia (Fig. 71a) and six from SE-Queensland (Fig. 71b) differ from the type specimens by having inferior appendages broader in lateral view. The pointed inferior appendages ressemble those of *E. cuspidis* and *E. bishopi*, but these species differ in the shape of the parameres.

Ecnomus kinka sp. nov.

Figures 73, 74

Type material. Holotype male, Western Australia, Morgan River, Theda H.S., Kimberleys, 28 Sep 1979, J. Blyth (NMV, T-10220).

Paratypes. 6 males (specimen CT-061 figured), collected with holotype (NMV).

Other material examined. Western Australia. 4 males, Granite Ck, Kununurra–L Argyle Hwy, 2 Feb 1978, J.E.B.

Northern Territory. 1 male, Jasper Ck, Victoria R. Downs Rd, 45 km SSE Timber Ck, 17 Sep 1979, J.B.; 2 males, Katherine R. Gorge Nat. Pk, 13 Aug 1979, J.B.; 7 males, Adelaide R., 15 km E of Stuart Hwy, 15 Aug 1979, J.B.; 33 males, South Alligator R., various sites, various dates 1988–1989, A.W., P.S.; 3 males, South Alligator R. at Gimbat OSS Station, 28 Apr 1988, P. Dostine; 16 males, SAR site 1, various dates 1988, P. Dostine; 88 males, Kambolgie Ck, 25–26 May 1988, A.W., P.S.; 1 male, Graveside Ck, 18 Jul 1988, P. Dostine; 6 males, Ck 5 km W of OSS Gimbat Field Station, 19 Apr 1989, A.W., P.S.; 6 males, Magela Ck, various sites and dates 1988, A.W., P.S.; 10 males, Magela Ck, S of Georgetown Billabong, 6 Nov 1982, A.J. Sharley (NTM); 2 males, ARRS Stag Ck at BHP camp, 25 May 1988, P.S., A.W.; 3 males, Gulungul Ck, inlet to Gulungul Billabong, 17 May 1988, A.W., P.S.; 1 male, same loc., 20 Apr 1989, A.W., P.S.; 1 male, Nourlangie Ck, 6 km E of Mt Cahill, 12°52′S, 132°46′E, 18 Nov 1972, J.C. Cardale (ANIC); 1 male, Cattle Ck, 54 km SW of Borroloola, 16°32′S, 136°10′E, 27 Oct 1975, J.C. Cardale (ANIC); 1 male, 14 km NW of Cape Crawford, 16°34′S, 135°41′E, 6 Nov 1975, J.C. Cardale (ANIC).

Queensland. 1 male, McLeod R., 15 km W of Mt Carbine, 22–23 Jun 1975, S.R. Monteith (ANIC); 2 males, 16 km S of Coen, 29 Nov 1974, M.S. Moulds; 1 male, Laura, Cape York Peninsula, 7 Oct 1979, M.S. and B.J. Moulds; 1 male, Alice R., Hervey Range Rd, 25 km W Townsville, 9 May 1979, A.W.

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view, broadest in basal half, tapered distally (Fig. 73). Inferior appendage in ventral view, length about 4× width, parallel sided, inner margin inflected towards middle of apical projection subapically (Fig. 74), as in *E. pilbarensis* sp. nov. In lateral view, paramere long and slender; phallus obliquely narrowed subapically (Fig. 73).

Female. Unknown.

Length of anterior wing: male 3.3–4.5 mm.

Etymology. Named after a Western Australian aboriginal word for many hills – *kinka* (type locality – Kimberley region).

Distribution. N-WA (Kimberley region), N-NT, NE-Qld (Fig. 117).

Remarks. The form of the inferior appendage is similar to *E. pilbarensis* sp. nov. but the species differ in other details.

Ecnomus pilbarensis sp. nov.

Figures 75, 76

Type material. Holotype male, Western Australia, Wittenoom Gorge, 10 km E of Roebourne Rd, Pilbara, 24 Oct 1979, J. Blyth (NMV, T-10227).

Paratypes. 5 males (specimen CT-022 figured), collected with holotype (NMV).

Other material examined. Western Australia. 3 males, Wooramel R., Gasgoyne Jn–Mullewa Rd, 11 Nov 1979, J.B.; 7 males, Wittenoom Gorge, Hamersley Range, 20 Feb 1977, M.S. and B.J. Moulds; 1 male, Fortescue Falls, Hamersley Range Nat. Pk, 27 Oct 1979, J.B.; 1 male, 15 km E of Millstream, 20 Oct 1970, J.C. Cardale (ANIC); 2 males, Crossing Pool, Millstream, 21 Oct 1970, J.C. Cardale (ANIC); 2 males, same loc., 21–22 Apr 1972, N.R. Mitchell (ANIC); 1 male, same loc., 21 Oct 1979, J.B.; 1 male, Millstream H.S., 21°35′S, 117°04′E, 2 Apr 1971, E.F. Riek (ANIC); 1 male, N of Carnarvon, De Grey Station Rd, 29 Apr 1972, N. McFarland; 7 males, Kimberley, 6.5 km NW Mt Bell, 17°10′S, 125°17′E, 25–26 Jul 1988, T.F. Houston (WAM); 1 male, Granite Ck, Kununurra–L Argyle Hwy, 2 Feb 1978, J.E.B.

Northern Territory. 2 males, Newcastle Waters, 10 km W of Elliot, 10 Aug 1979, J.B.; 1 male, 14 km NW of Cape Crawford, 16°34′S, 135°41′E, 6 Nov 1975, J.C. Cardale (ANIC).

Queensland. 1 male, Stoney Ck on Mt Stuart Rd, Stuart, Townsville, 27 Apr 1979, A.W.; 2 males, Upper Ross R. below weir SW of Townsville, 8 May 1979, A.W.

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view, length about 2× width, broadest in basal half, tapered distally (Fig. 75). Inferior appendage in ventral view length about 2.5× width, narrowed in median section, inner margin inflected towards middle of apical projection subapically (Fig. 76).

as in *E. kinka*. In lateral view, paramere straight with slightly spatulate apex; phallus obliquely narrowed subapically, extended into a short process apically (Fig. 75).

Female. Unknown.

Length of anterior wing: male 4.4–4.8 mm.

Etymology. Named after the Pilbara region (type locality).

Distribution. N-WA, N-NT, NE-Qld (Fig. 118).

Remarks. *E. pilbarensis* is a widespread northern Australian species, similar to *E. kinka* in the form of the inferior appendage.

Ecnomus larakia sp. nov.

Figures 77, 78

Type material. Holotype male, Northern Territory, Howard Springs, 9 Sep 1980, D. King (NMV, T-10233).

Paratypes. 11 males (specimen CT-072 figured), collected with holotype (NMV).

Other material examined. Western Australia. 1 male, Drysdale R. at Kalumburu Rd crossing, Kimberleys, 28 Sep 1979, J.B.

Northern Territory. 9 males, Lambell's Lagoon, Humpty Doo, 19 Aug 1979, J.B.; 4 males, Jim Jim Ck on Kakadu Hwy, 28 May 1988, P.S., A.W.; 7 males, Goanna Lagoon, 1 km W of Jabiru off Arnhem Hwy, 27 Jun 1979–27 Mar 1980, R. Marchant; 5 males, Georgetown Billabong nr Jabiru, 27 Jun 1983–25 Jul 1983, A.J. Sharley (NTM); 2 males, Corndorl Billabong nr Jabiru, 6–8 Nov 1982, A.J. Sharley (NTM); 1 male, ARRS Coonjimba Billabong, 19 May 1988, P.S., A.W.; 19 males, ARRS Gulungul Ck, inlet to Gulungul Billabong, 17 May 1988, P.S., A.W.; 6 males, same loc., 20 Apr 1989, A.W., P.S.; 19 males, same loc., 11 Apr 1989, P.S., A.W.; 1 male, ARRS Magela Ck at Ranger pipe outlet, 20 May 1988, A.W., P.S.; 11 males, Nourlangie Ck, 8 km N of Mt Cahill, 12°48′S, 132°42′E, 16–17 Jun 1973, J.C. Cardale (ANIC); 1 male, 12 km NNW of Mt Cahill, 12°46′S, 132°39′E, 15–16 Jun 1973, J.C. Cardale (ANIC); 8 males, Nourlangie Camp Lagoon, Kakadu Nat. Pk, 4 Sep 1979, J.B.

Queensland. 1 male, swamp, 28 km N of Laura, 30 Nov 1974, Moulds; 1 male, Ross R. at Apex Pk nr Townsville, 26 Apr 1979, A.W.

Description. Male. Wings pale fawn. Genitalia with superior appendage short, in lateral view broadbased, tapered strongly distally (Fig. 77). Inferior appendage in ventral view, length about 3× width, slightly constricted medially, dilated subapically, tapered to a pointed apex (Fig. 78). In lateral view, paramere short and robust; phallus obliquely narrowed subapically (Fig. 77).

Female. Unknown.

Length of anterior wing: male 2.9–3.5 mm.

Etymology. Named after the Larakia aboriginal tribe, who inhabited the region including the type locality.

Distribution. N-WA (Kimberley region), N-NT, NE-Qld (Fig. 112).

Remarks. A small species, distinguished from others by small differences in the inferior appendages. The shape of the superior and inferior appendages are very similar to *E. kitabal*, which differs in possessing a process on segment nine.

Ecnomus pakadji sp. nov.

Figures 79, 80

Type material. Holotype male, Queensland, Iron Range, West Claudie River, 17 Sep 1974, M.S. Moulds (NMV, T-10245, figured specimen CT-052).

Description. Male. Wings pale fawn. Genitalia with superior appendage long, in lateral view length about 3× width (Fig. 79). Inferior appendage long, in ventral view length about 3× width, slightly inflected and tapered slightly distally, with a small process apically (Fig. 80). In lateral view, paramere robust with apex slightly dilated; phallus lacking ventral subapical swelling (Fig. 79).

Female. Unknown.

Length of anterior wing: male 4.0 mm.

Etymology. Named after the Pakadji aboriginal tribe who inhabited the region including the type locality.

Distribution. NE-Qld (known from type locality only) (Fig. 112).

Remarks. Only one male specimen is known for this species. It differs sufficiently from all other species in genitalic characters to warrant being placed in a separate species.

Ecnomus walajandari sp. nov.

Figures 81, 82

Type material. Holotype male, Western Australia, Spillway Ck, Ord River Dam, 2 Feb 1978, J.E. Bishop (NMV, T-10246).

Paratypes. 11 males (specimen CT-065 figured), collected with holotype (NMV).

Other material examined. Western Australia. 1 male, Spillway Ck, Ord R. Dam, 20 Feb 1978, J.E.B.; 2 males, Ord R. at Kununurra Dam, 22 Feb 1977, J.E.B.; 8 males, Deadhorse Springs, L Argyle, 19 Feb 1977, J.E.B.; 9 males, stream opposite Deadhorse Gap, L

Argyle, 19 Feb 1977, J.E.B.; 2 males, Mitchell Plateau, Camp Ck at crusher, 18 Feb 1979, J.E.B.; 1 male, Charnley R., 16°22′S, 125°12′E, 2 km SW Rolly Hill, 16–20 Jun 1988, I.D. Naumann (ANIC).

Northern Territory. 1 male, Katherine R. Gorge Nat. Pk, 26 Jan 1977, M.S. and B.J. Moulds; 1 male, same loc., 13 Aug 1979, J.B.; 1 male, ARRS Kambolgie Ck, 25 May 1988, P.S., A.W., 1 male, SAR Rock Hole Ck, November 1988, P. Dostine; 1 male, South Alligator R. nr Koolpin Crossing, 14 Oct 1987, P. Dostine; 1 male, ARRS South Alligator R. above Fisher Ck jn, 24 May 1988, A.W., P.S.; 1 male, ARRS South Alligator R. below Fisher Ck jn, 24 May 1988, A.W., P.S.; 3 males, ARRS South Alligator R. above BHP camp, 25 May 1988, A.W., P.S.; 9 males, ARRS South Alligator R. at Gimbat OSS Station, 28 May 1988, P. Dostine; 3 males, SAR, site 1, 14 Jun 1988, P. Dostine; 3 males, same loc., October 1988, P. Dostine; 2 males, ARRS Graveside Gorge, 18 Jul 1988, P. Dostine; 1 male, Bowerbird Billabong outlet, 1 Oct 1988, P. Dostine.

Description. Male. Wings pale fawn. Genitalia with superior appendage in lateral view broadest in basal half, tapered gradually distally (Fig. 81). Inferior appendage in ventral view, very similar to *E. wagengugurra* but more robust, length about 2× width, inner margin inflected towards base of apical point (Fig. 82). In lateral view, paramere moderately slender; phallus lacking ventral subapical swelling (Fig. 81).

Female. Unknown.

Length of anterior wing: male 2.9–3.7 mm.

Etymology. Named after the Walajandari aboriginal tribe who inhabited the region including the type locality.

Distribution. N-WA (Kimberley region), N-NT (Fig. 120).

Remarks. A small species, resembling *E. wagengugurra* in the form of the inferior appendages, but differs in other characters, especially the shape of the processes on the tenth segment.

Discussion

Neboiss (1981) has recognized three major Australian faunal provinces based on climatic zones, with associated distributional barriers and refuge areas. Although species of *Ecnomus* are distributed over most of the continent, species richness is greatest in wet-tropical and eastern Australia. Numbers of species in each province and region are shown in Fig. 109. Twenty-seven species are known from the Torresian province, 21 from the Bassian and seven from the drier Eyrean province. The fauna is particularly rich in parts of the Torresian province with 19 species in the Kimberley region of north-western Australia, 22 species in the northern half of the Northern Territory and 16 species in NE-Queensland. Of the 27 species found in the Torresian province, eight are restricted to the Kimberley and Northern Territory regions and two are endemic to NE-Queensland. The remainder are widely distributed across northern Australia including six northern species which extend their ranges into the NE-Bassian province, several as far south as the Clarence River in NE-New South Wales. Within the Eyrean province, three species occur in the Pilbara region of Western Australia while four species occur in the eastern half. In the Pilbara *E. ingibandi* is endemic, while the other two species occur widely throughout the Torresian province. In the eastern half of the province, *E. centralis* is mostly restricted to that region, while *E. continentalis, E. pansus* and *E. turgidus* are also widely distributed in the Bassian and limited areas of the Torresian provinces. Most species in the Bassian province have been recorded from SE-Queensland, NE-New South Wales and Victoria. Only three species are recorded from Tasmania and two from SW-Australia, with none of the species being endemic.

The distribution of species of *Ecnomus* provides support for the following faunal barriers or disjunctions recognized by Campbell (1981), Keast (1981), Neboiss (1981) and Watson and Theischinger (1984) (Fig. 109):

1. Between Townsville and Eungella Range, east coast barrier for 13 out of 15 "southern" species (exceptions *E. continentalis* and *E. wellsae*), and 17 out of 23 "northern" species. The NE-Bassian region between disjunction 1 and the Clarence River, NE-NSW, appears to be an overlap zone for many Torresian and Bassian species, with six "northern" and nine "southern" species reaching their southern and northern range limits, respectively within the zone.

2. Bass Strait, southern barrier for 12 out of 15 Bassian species.

3. Nullabor Plain, western barrier for all but two eastern Bassian species. The exceptions are *E. pansus* and *E. turgidus*.

4. Semi-desert, north of Geraldton, Western Australia, west coast disjunction for "northern" (Torresian and Pilbara region) and Bassian species.

5. Great Sandy Desert in northern Western Australia, southern barrier on west coast for 17 out of 19 species from the Kimberley region and northern barrier for *E. ingibandi*, endemic to the

Pilbara region, and is closely related to two species found in the Kimberley region.

6. Steppe areas south of the Gulf of Carpentaria, a weaker disjunction restricting eight out of 22 western Torresian species and five out of 16 eastern Torresian species, although 13 of the 27 species found in the Torresian region do occur in both areas.

The Australian fauna is almost as rich as that of Africa. *Ecnomus* is also well represented in the Pakistan–India–Sri Lanka region, with 15 described species (Fischer, 1960–1973) and Papua-New Guinea with about 19 species (including 17 undescribed species, pers. obs.). The concentration of approximately three-quarters of the known *Ecnomus* fauna in the African and Australian regions, and the Indian subcontinent suggests a Gondwanan origin, however, *Ecnomus* has not been recorded from South America or New Zealand. Therefore valid arguments could be made for an Oriental origin with dispersal and subsequent speciation in Africa and Australia.

Males of Australian species of *Ecnomus* are characterized by a pair of superior appendages which range from long and slender to short and broadbased; a pair of inferior appendages which vary from long and slender to short and broad with several processes; a pair of parameres which are mostly shorter than the phallus, with apices usually either tapered and straight or curved downwards to form a hook. *E. veratus* is an exception as it has a single, highly modified paramere, which is elongated and downcurved. The shape of the phallus is conservative, usually narrowing subapically, with or without a prominant ventral swelling and spines. All species have a pair of short, simple processes located on segment ten.

In this study, 12 *Ecnomus* females from southern Australia are described. Ten of these species have a "pocket" on each of the ventral plates. The position and shape of these "pockets" is diagnostic, and seems to correspond with the position and shape of the mesal projections on the inferior appendages of the males, which form a "key in lock" pairing during copulation. "Pockets" have not been described before in *Ecnomus* females and perhaps this group of southern Australian species forms a distinct phylogenetic group. The widespread distribution of species in Australia and the diversity of male genitalic structures, however, suggests that Australian species may not all be monophyletic in origin.

Very little has been discussed regarding the phylogeny of the genus *Ecnomus*. Kimmins (1957), Scott (1968) and Barnard and Clark (1986) have all detailed characteristics which distinguish the *natalensis*-group of species from Africa. This group of about 23 species (Barnard and Clark 1986), is recognized by males with inferior appendages having a dorsal finger-like extension and a spur formula 2.4.4, as opposed to the usual 3.4.4. Barnard and Clark (1986) also distinguished a subgroup within the *natalensis*-group of about ten species which have the apex of the phallus divided into a pair of flattened plates and parameres with a pre-apical tooth. Barnard and Clark (1986) suggested that the *natalensis*-group is monophyletic, due to the particular form of the male genitalia, although no other species groups have yet been recognized within the genus. Males of Australian species also differ from the type species, *E. tenellus*, which is characterized by a phallus with a subapical process and no parameres (Schmid, 1961).

Many of the northern Australian species have superior appendages which are broadbased and short, which is a characteristic shared with many African species (Kimmins, 1957; Scott, 1963). However most southern and eastern Australian species have superior appendages which are long and relatively uniform in width, a characteristic shared with many described Oriental species (Mosely, 1932; Schmid, 1958; Ulmer, 1951) and undescribed species from Sulawesi and Papua-New Guinea (pers. obs.).

When the *Ecnomus* fauna is more completely known, there will be scope for a detailed phylogenetic and zoogeographic study of the genus.

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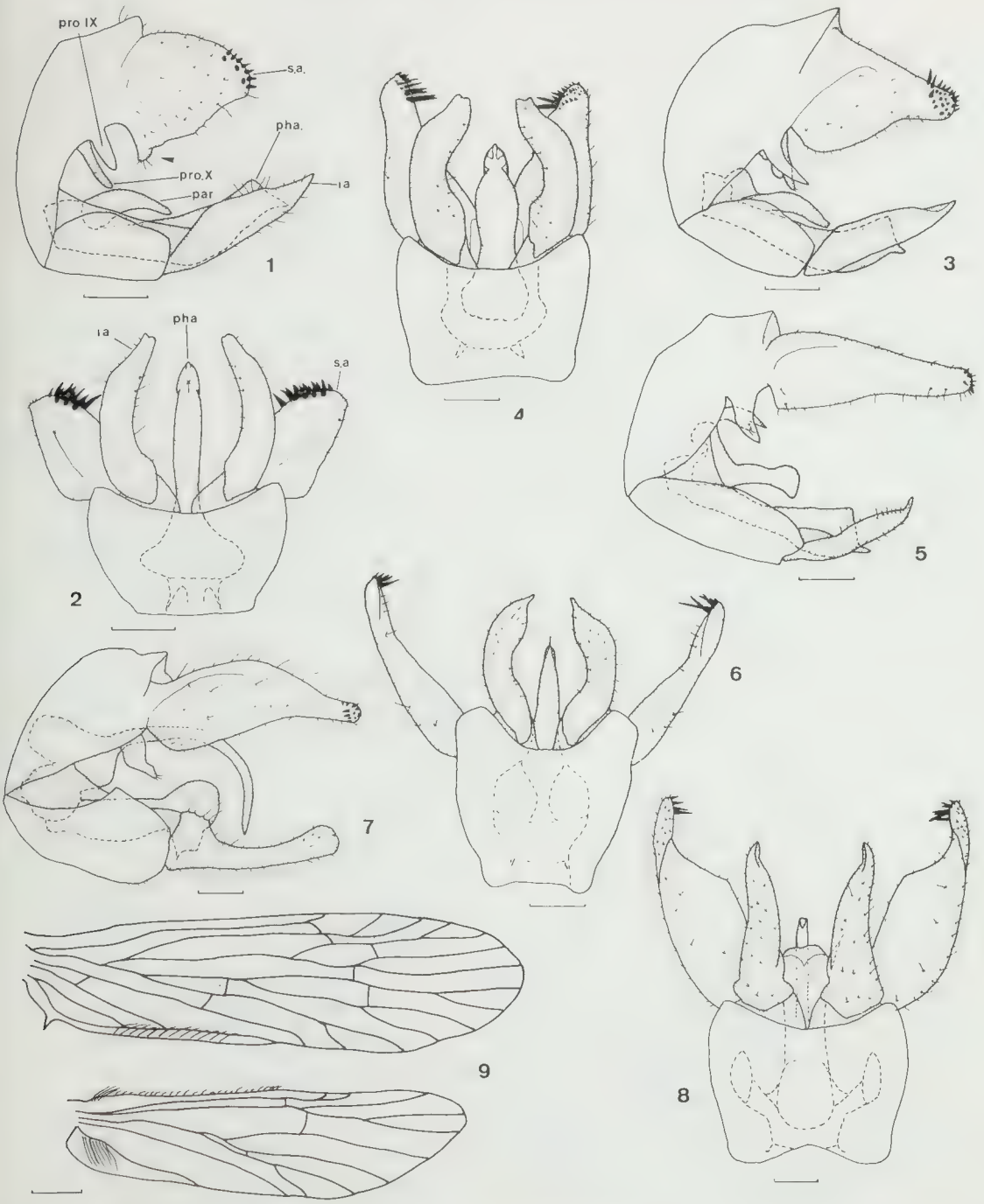


Figures 1–9. *Ecnomus* spp. Males.

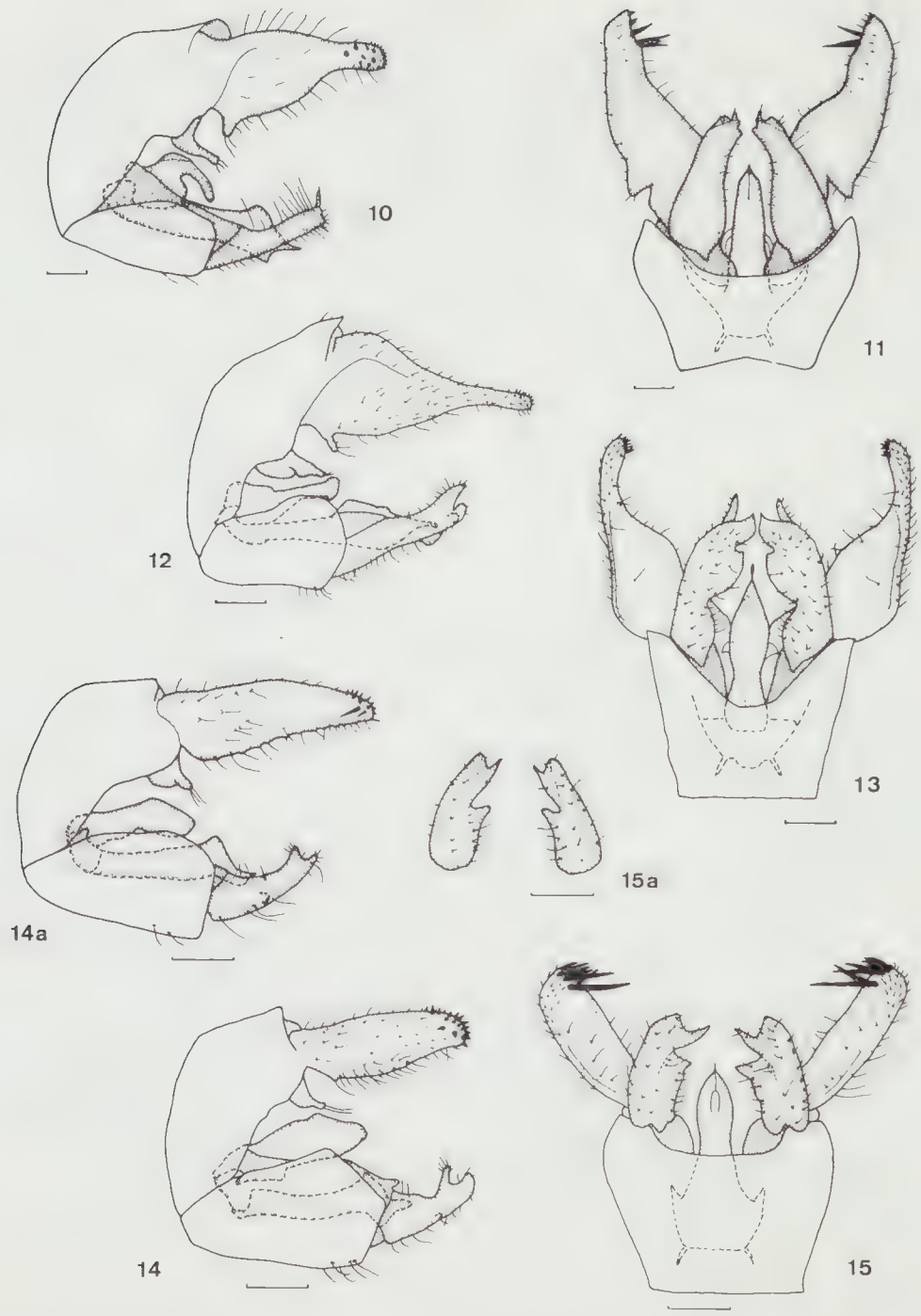
1, 2. *Ecnomus ingibandi* sp. nov., paratype, N-WA. (CT-053); genitalia: 1, lateral view; 2, ventral view; i.a., inferior appendage; par., paramere; pha., phallus; pro. IX, process on ninth abdominal segment; pro. X, process on tenth abdominal segment; s.a., superior appendage.

3, 4. *Ecnomus kitabal* sp. nov., paratype, NE-NSW. (CT-044); genitalia: 3, lateral view; 4, ventral view.

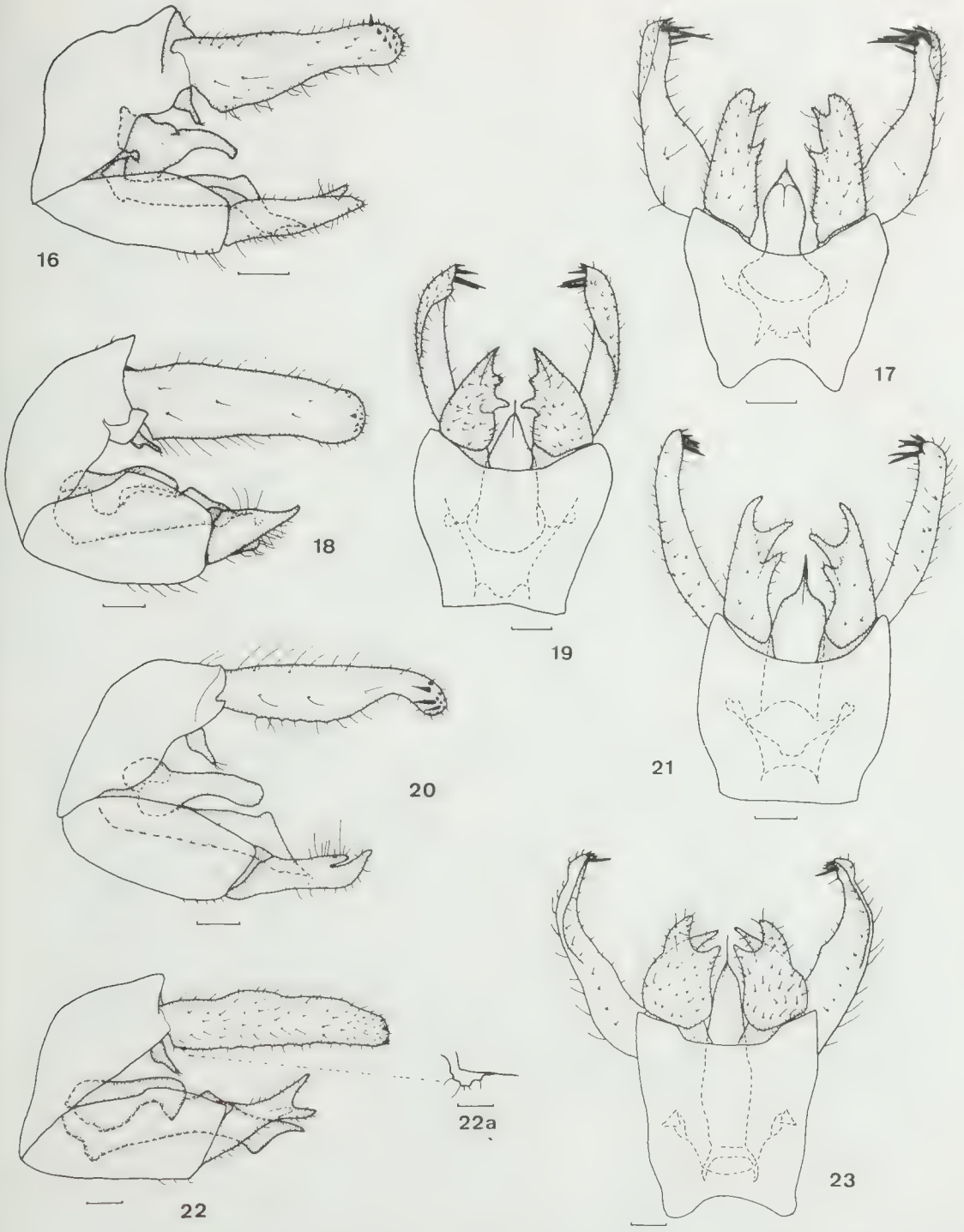
5, 6. *Ecnomus jimba* sp. nov., paratype, N-WA. (CT-046); genitalia: 5, lateral view; 6, ventral view.

7–9. *Ecnomus veratus* sp. nov., paratype, N-NT. (CT-056): 7, genitalia, lateral view; 8, genitalia, ventral view; 9, wing venation.

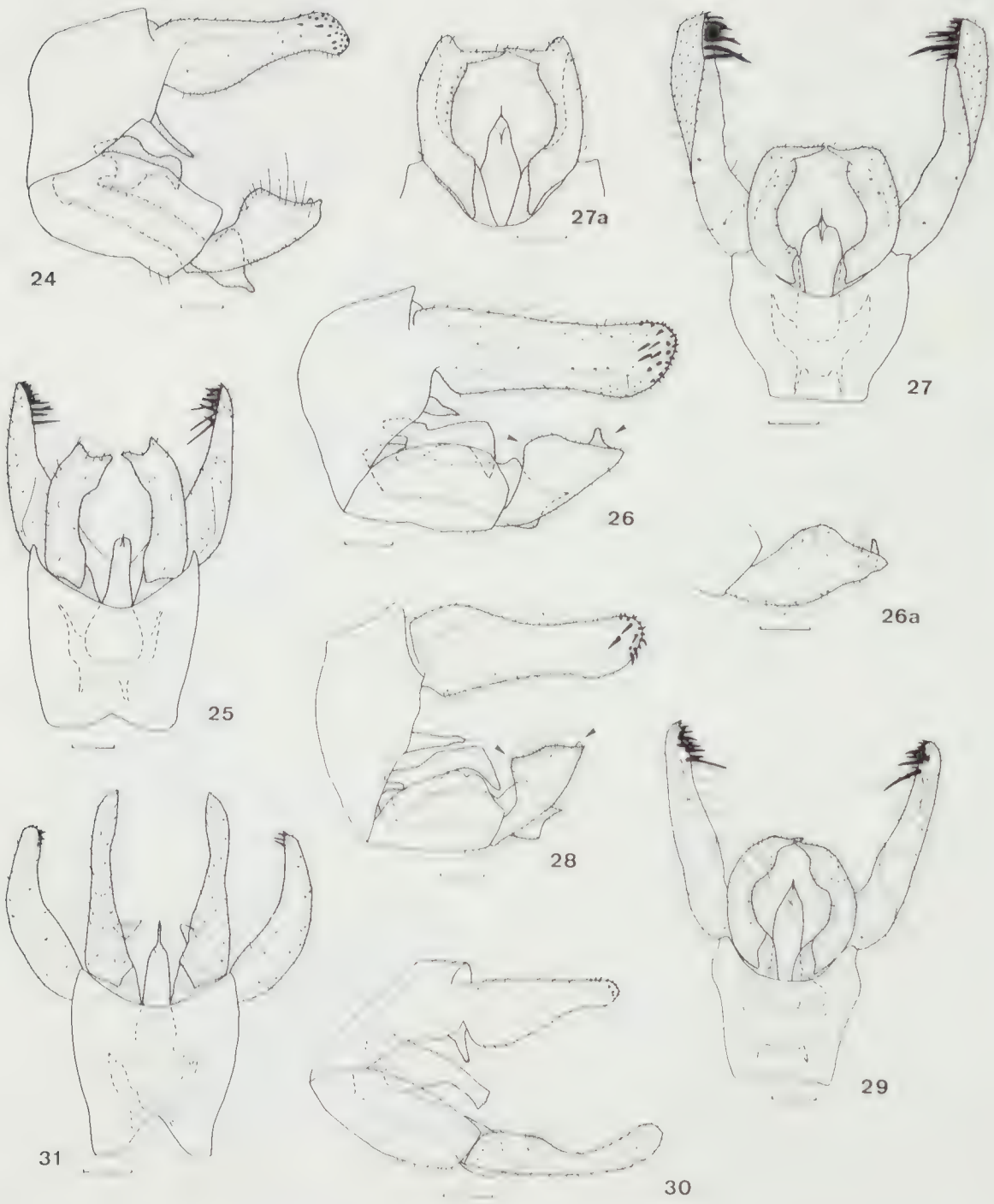
Scale lines: figs 1–8, 0.1 mm; fig. 9, 0.5mm.



Figures 10–15. *Ecnomus* spp. Male genitalia.
10, 11. *Ecnomus turgidus* Neboiss, paratype, S-WA. (CT-026): 10, lateral view; 11, ventral view.
12, 13. *Ecnomus digrutus* sp. nov., paratype, N-WA. (CT-067); 12, lateral view; 13, ventral view.
14, 15. *Ecnomus woronan* sp. nov., paratype, N-WA. (CT-078): 14, lateral view; 15, ventral view.
14a, 15a. *Ecnomus woronan* sp. nov. (variety), NE-Qld. (CT-063): 14a, lateral view; 15a, inferior appendage, ventral view.
Scale lines: all 0.1 mm.



Figures 16–23. *Ecnomus* spp. Male genitalia.
16, 17. *Ecnomus kakaduensis* sp. nov., paratype, N-NT. (CT-066): 16, lateral view; 17, ventral view.
18, 19. *Ecnomus wellsae* sp. nov., paratype, NE-NSW. (CT-017): 18, lateral view; 19, ventral view.
20, 21. *Ecnomus tridigitus* sp. nov., paratype, NE-NSW. (CT-012): 20, lateral view; 21, ventral view.
22, 23. *Ecnomus neboissi* sp. nov., holotype, E-Vic. (CT-031): 22, lateral view; 22a, superior appendage, basiventral angle, ventro-lateral view; 23, ventral view.
Scale lines: all 0.1 mm.



Figures 24–31. *Ecnomus* spp. Male genitalia.

24, 25. *Ecnomus turrbal* sp. nov., paratype, SE-Qld. (CT-041): 24, lateral view; 25, ventral view.

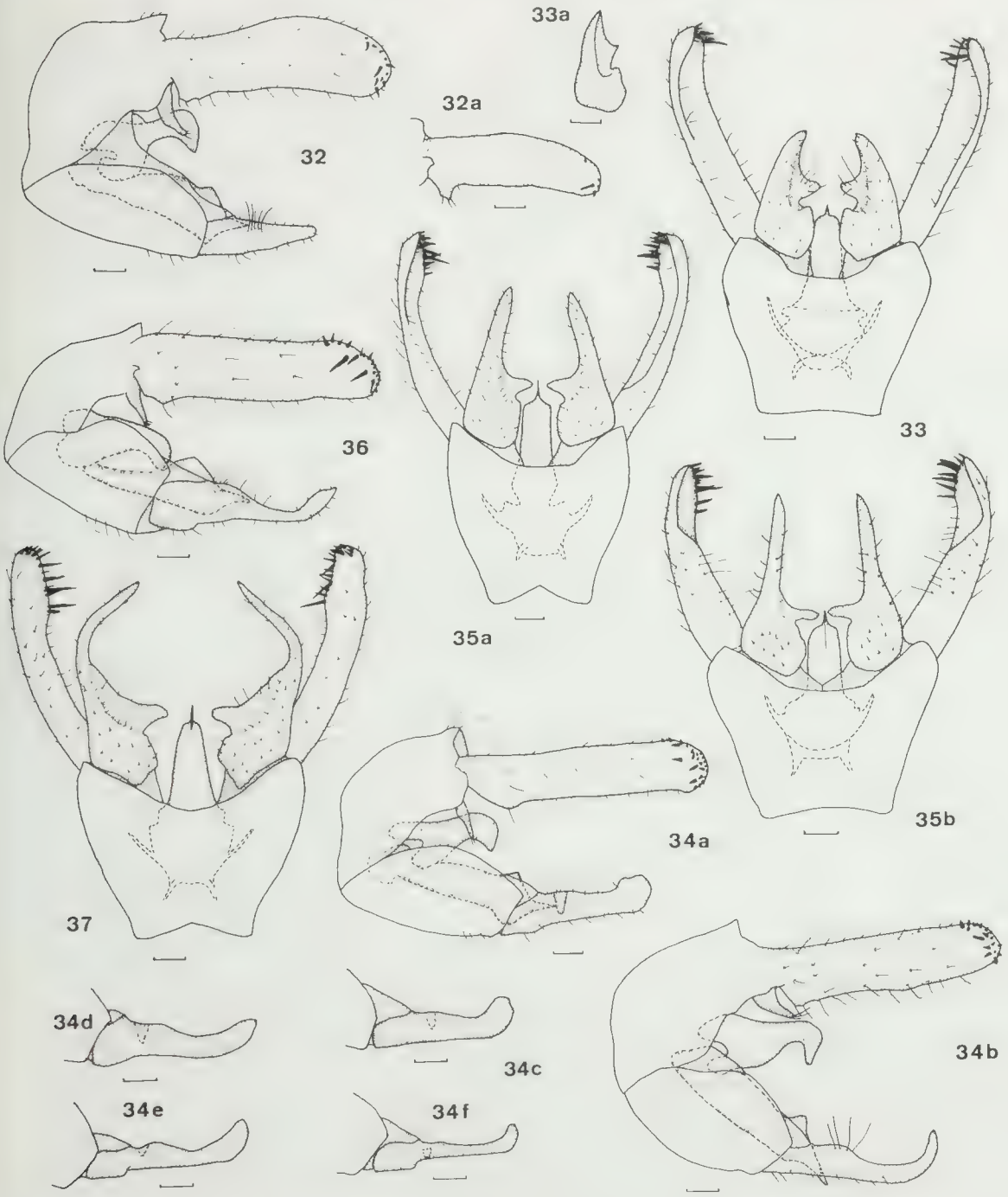
26, 27. *Ecnomus cuspidis* sp. nov., paratype, NE-Qld. (CT-073): 26, lateral view; 27, ventral view.

26a, 27a. *Ecnomus cuspidis* sp. nov. (variety), SE-Qld. (CT-074), inferior appendages: 26a, lateral view; 27a, ventral view.

28, 29. *Ecnomus bishopi* sp. nov., paratype, N-WA. (CT-079): 28, lateral view; 29, ventral view.

30, 31. *Ecnomus clavatus* sp. nov., paratype, N-NT. (CT-043): 30, lateral view; 31, ventral view.

Scale lines: all 0.1 mm.



Figures 32–37. *Ecnomus* spp. Male genitalia.

32, 33. *Ecnomus deani* sp. nov. paratype, Vic. (CT-013): 32, lateral view; 33, ventral view.

32a, 33a. *Ecnomus deani* sp. nov. (variety), Vic. (CT-036): 32a, superior appendage, lateral view; 33a, inferior appendage, ventral view.

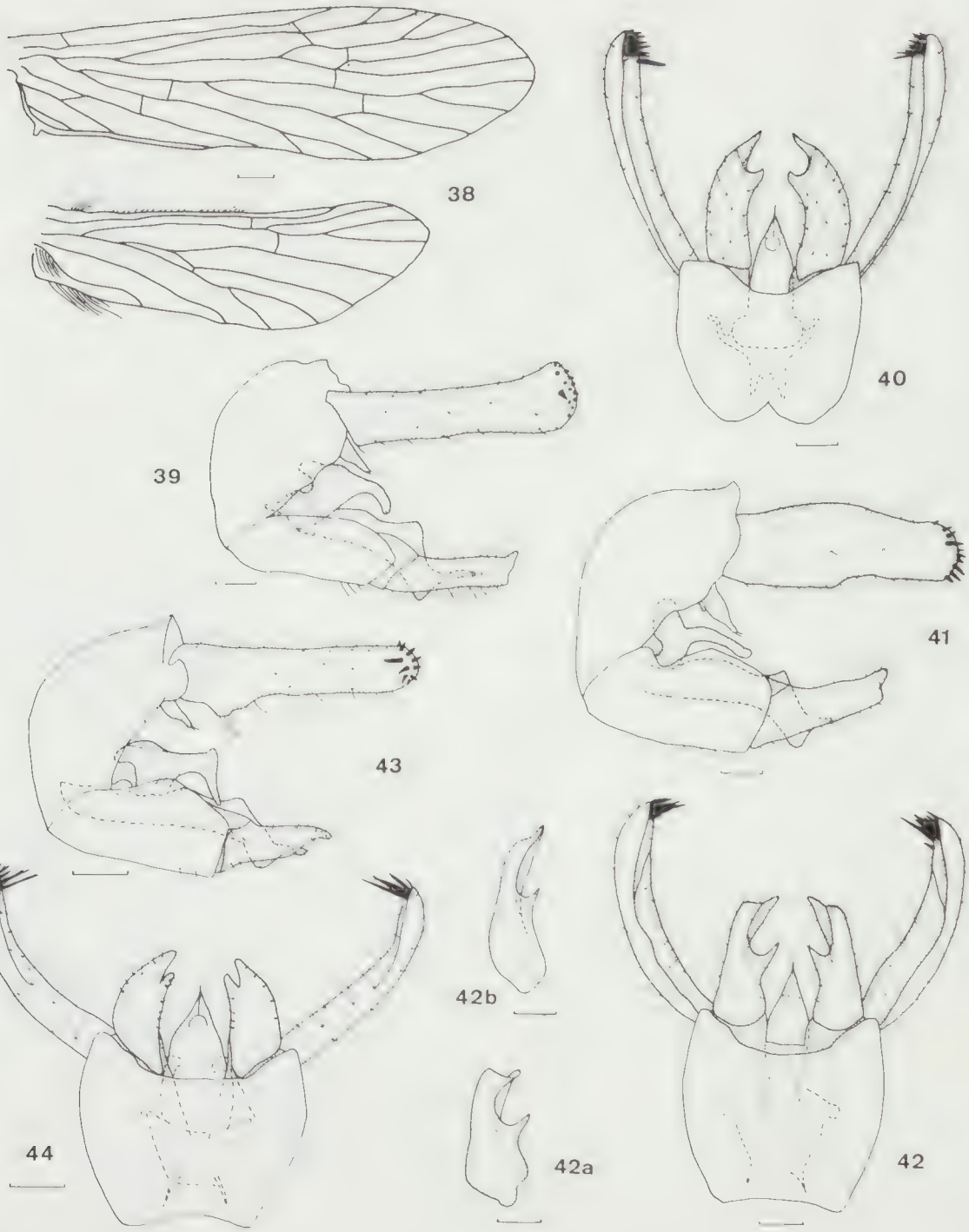
34a, 35a. *Ecnomus tillyardi* Mosely, Tas. (CT-024): 34a, lateral view; 35a, ventral view.

34b, 35b. *Ecnomus tillyardi* Mosely (variety), E-Vic. (CT-011) 34b, lateral view; 35b, ventral view.

34c–f. *Ecnomus tillyardi* Mosely (varieties), inferior appendage, lateral: 34c, nr Naracoorte, SE-SA. (CT-033); 34d, L Purrumbete, Vic. (CT-035); 34e, SW Kyneton, Vic. (CT-034); 34f, SW Healesville, Vic. (CT-050).

36, 37. *Ecnomus volsellus* sp. nov., paratype, Vic. (CT-014): 36, lateral view; 37, ventral view.

Scale lines: all 0.1 mm.



Figures 38–44. *Ecnomus* spp. Males.

38, *Ecnomus volsellus* sp. nov., paratype, Vic. (CT-014): wing venation.

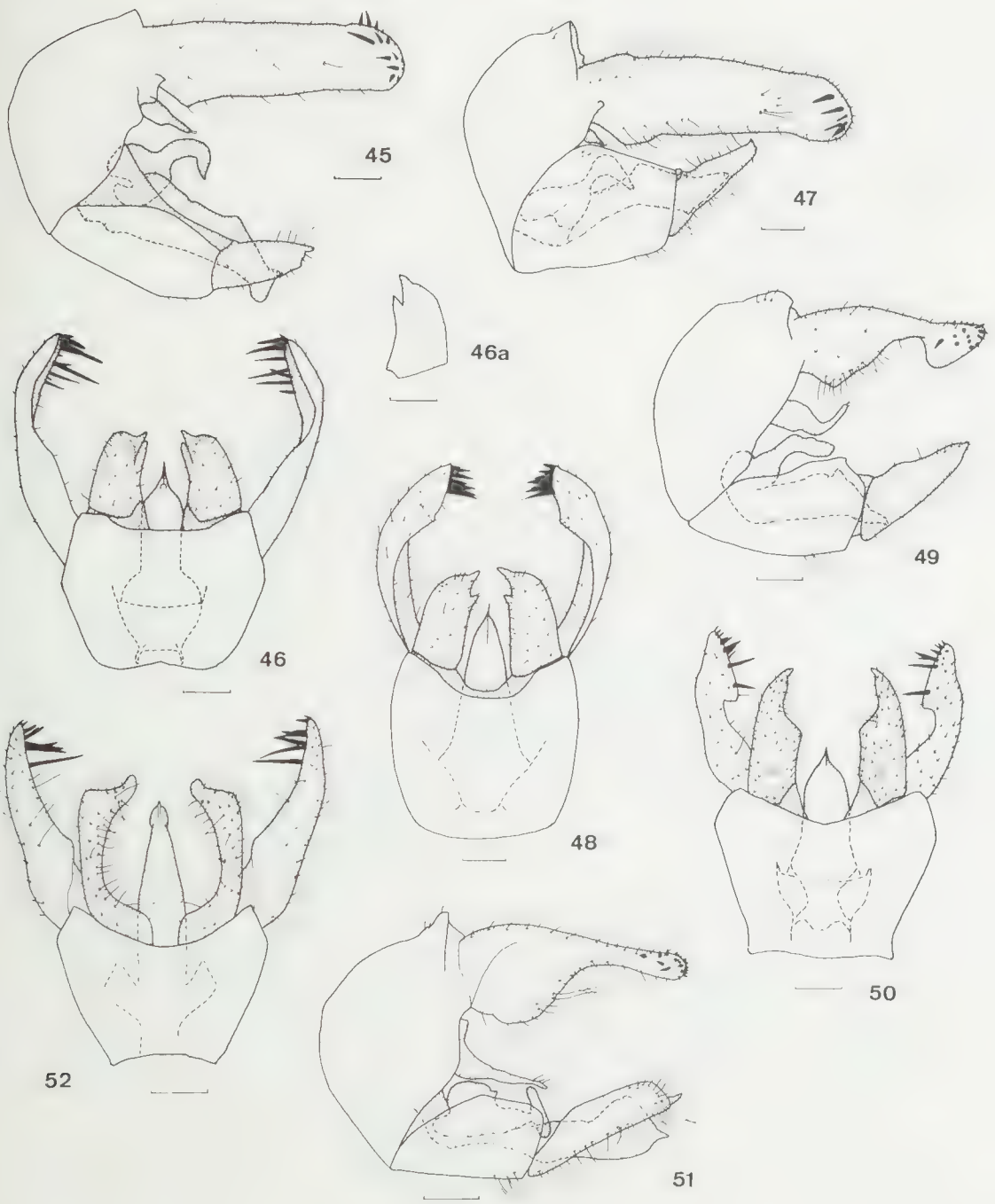
39, 40. *Ecnomus pansus* Neboiss, paratype, S-WA. (CT-027), genitalia: 39, lateral view; 40, ventral view.

41, 42. *Ecnomus cygnitus* Neboiss, Vic. (CT-025), genitalia: 41, lateral view; 42, ventral view.

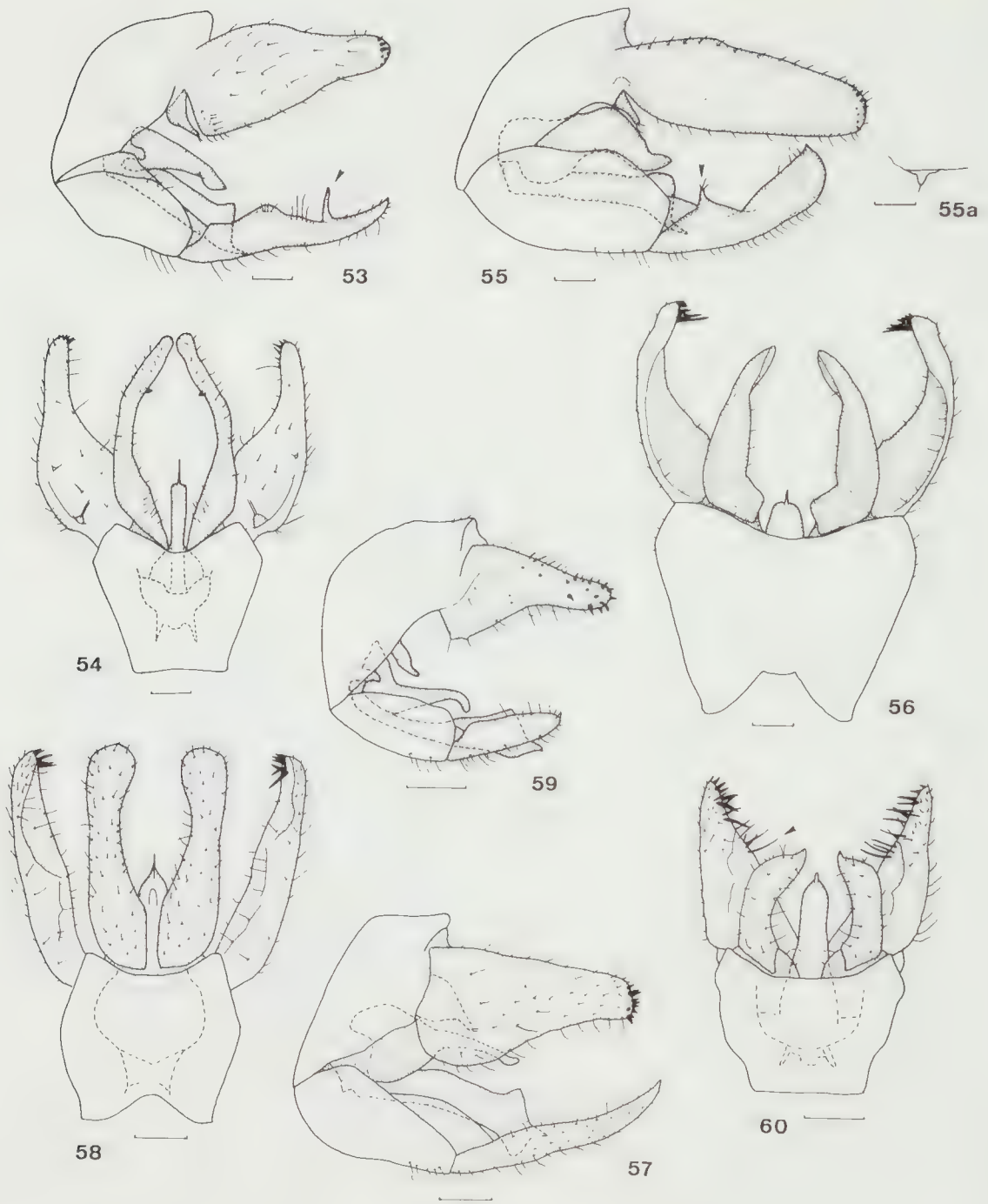
42a, 42b. *Ecnomus cygnitus* Neboiss (varieties), inferior appendage, ventral: 42a, SE-Qld. (PT-557); 42b, Tas. (PT-458).

43, 44. *Ecnomus kerema* sp. nov., holotype, NE-Qld. (CT-103), genitalia: 43, lateral view; 44, ventral view.

Scale lines: fig. 38, 0.5 mm; figs 39–44, 0.1 mm.



Figures 45–52. *Ecnomus* spp. Male genitalia.
45, 46. *Ecnomus continentalis* Ulmer, NE-Qld. (CT-028): 45, lateral view; 46, ventral view.
46a, inferior appendage, apico-ventral view.
47, 48. *Ecnomus nibbor* sp. nov., paratype, Vic. (CT-016): 47, lateral view; 48, ventral view.
49-50. *Ecnomus ancisus* sp. nov., paratype, N-WA. (CT-051): 49, lateral view; 50, ventral view.
51, 52. *Ecnomus blythi* sp. nov., paratype, N-NT. (CT-057): 51, lateral view; 52, ventral view.
Scale lines: all 0.1 mm.



Figures 53–60. *Ecnomus* spp. Male genitalia.

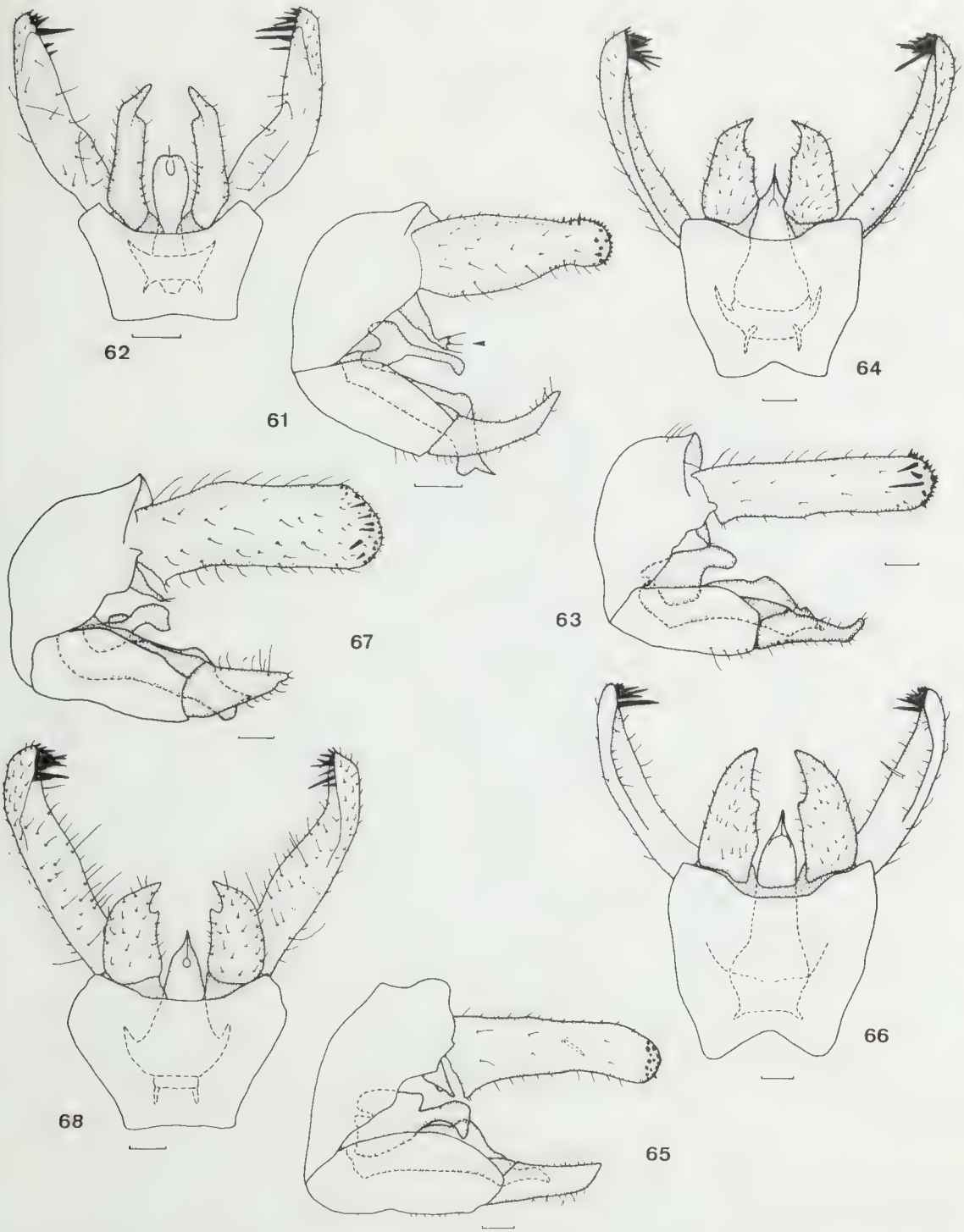
53, 54. *Ecnomus centralis* sp. nov., paratype, SW-Qld. (CT-038): 53, lateral view; 54, ventral view.

55, 56. *Ecnomus myallensis* sp. nov., paratype, SE-Qld. (CT-042): 55, lateral view; 55a, superior appendage, basiventral angle, ventro-lateral view; 56, ventral view

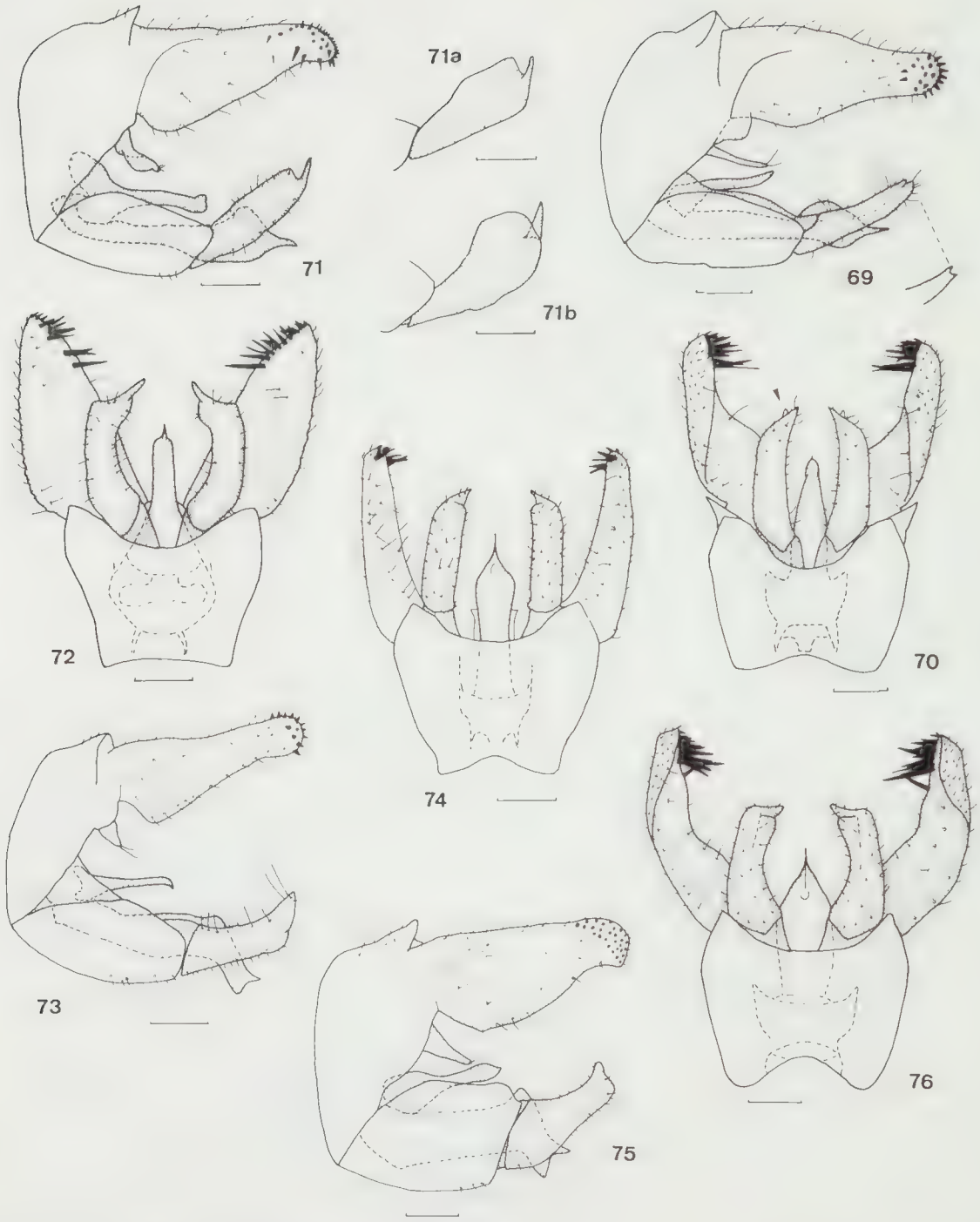
57, 58. *Ecnomus yabbura* sp. nov., paratype, N-WA. (CT-060): 57, lateral view; 58, ventral view.

59, 60. *Ecnomus miriwud* sp. nov., paratype, N-WA. (CT-068): 59, lateral view; 60, ventral view.

Scale lines: all 0.1 mm.



Figures 61–68. *Ecnomus* spp. Male genitalia.
61, 62. *Ecnomus wagengugurra* sp. nov., paratype, NE- NSW. (CT-062): 61, lateral view; 62, ventral view
63, 64. *Ecnomus karawalla* sp. nov., holotype, W-Vic. (CT-032): 63, lateral view; 64, ventral view.
65, 66. *Ecnomus russellius* Neboiss, Tas. (CT-029): 65, lateral view; 66, ventral view.
67, 68. *Ecnomus karakoi* sp. nov., holotype, Vic. (CT-030): 67, lateral view; 68, ventral view.
Scale lines: all 0.1 mm.



Figures 69–76. *Ecnomus* spp. Male genitalia.

69, 70. *Ecnomus tropicus* sp. nov., paratype, NE-Qld. (CT-069): 69, lateral view, apex of inferior appendage, ventro-lateral view; 70, ventral view.

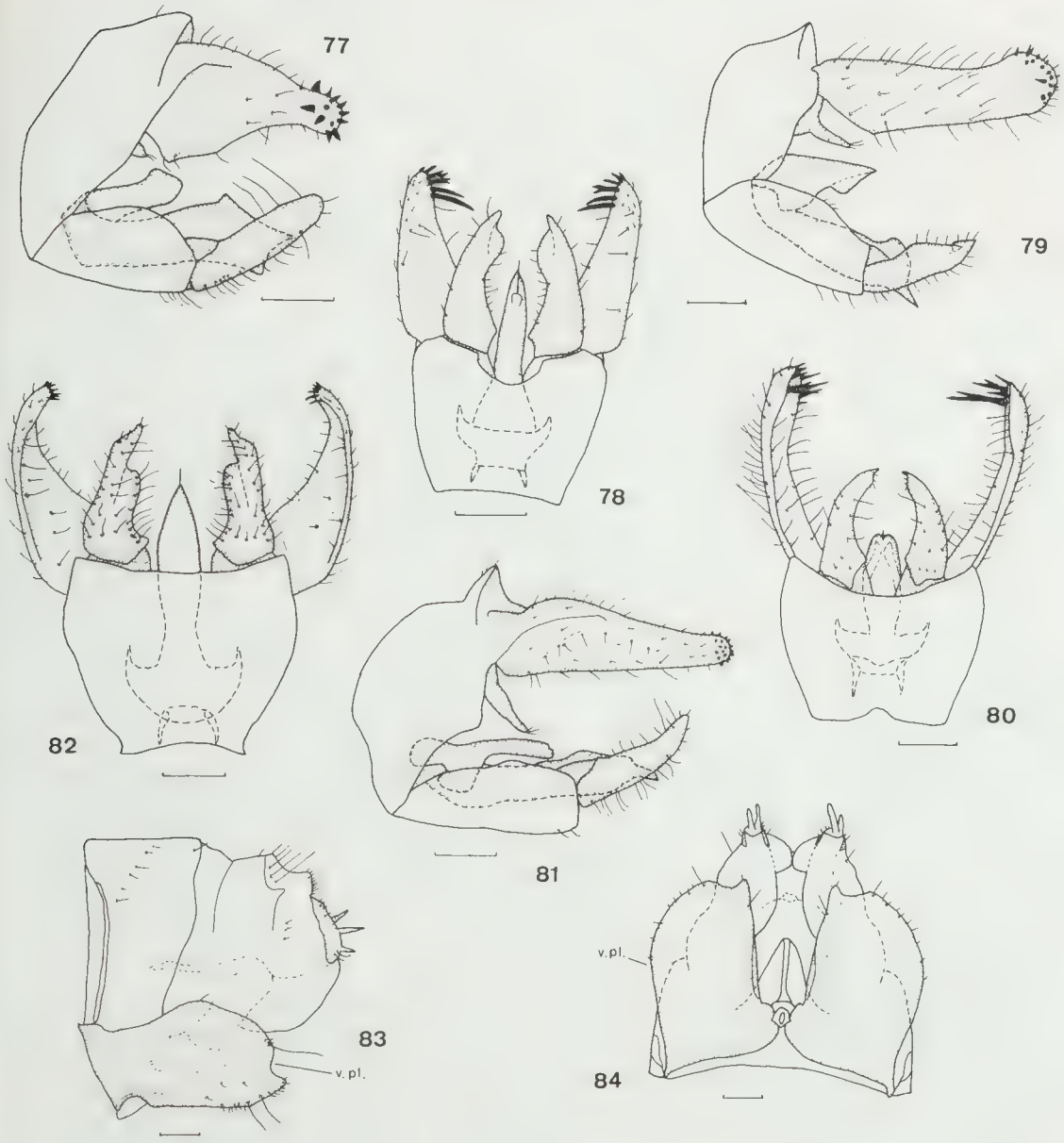
71-72. *Ecnomus apiculatus* sp. nov., paratype, N-WA. (CT-018): 71, lateral view; 72, ventral view.

71a, 71b. *Ecnomus apiculatus* sp. nov. (varieties), inferior appendage, lateral: 71a, N-WA. (CT-039); 71b, SE-Qld. (CT-039).

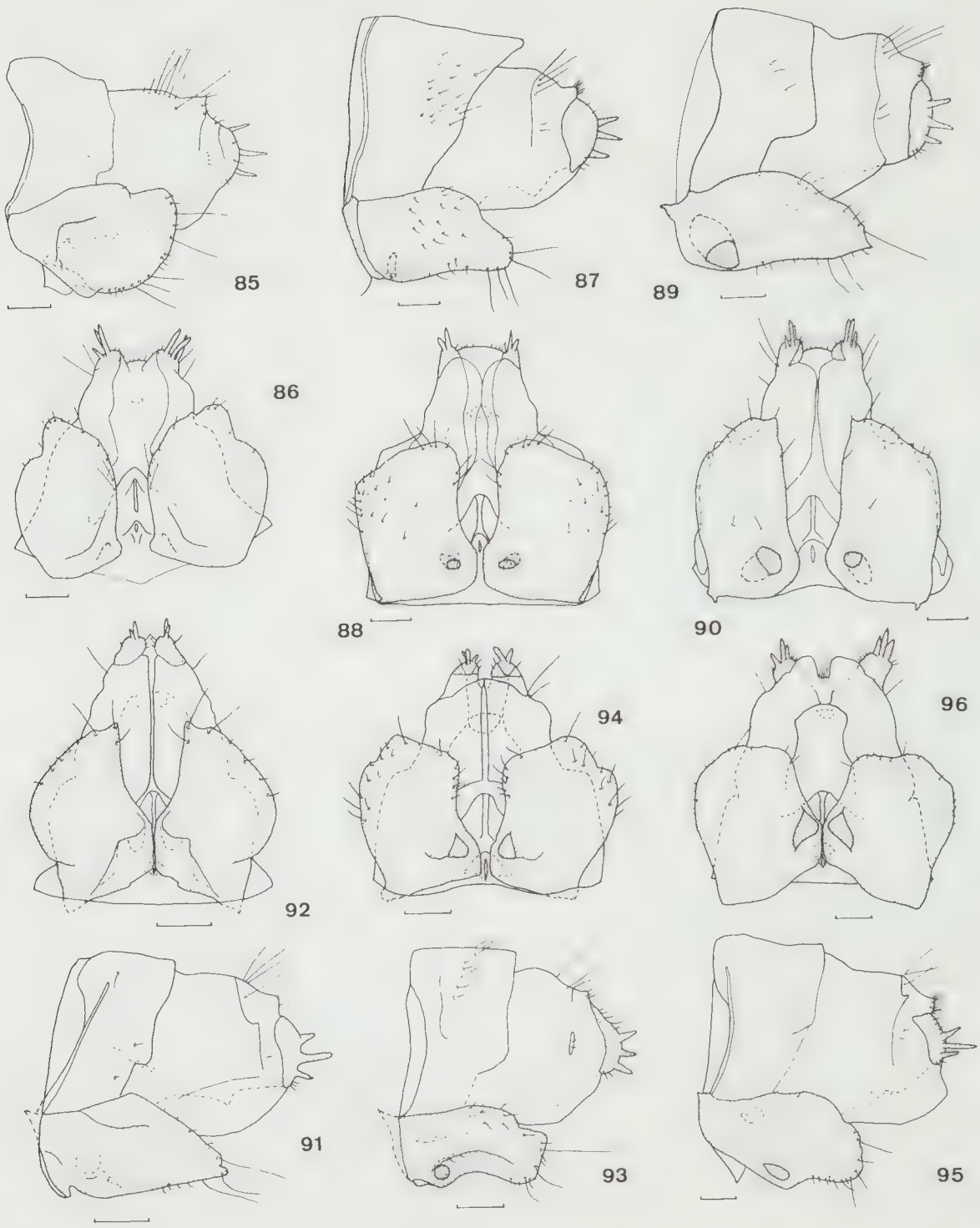
73, 74. *Ecnomus kinka* sp. nov., paratype, N-WA. (CT-061): 73, lateral view; 74, ventral view.

75, 76. *Ecnomus pilbarensis* sp. nov., paratype, N-WA. (CT-022); 75, lateral view; 76, ventral view.

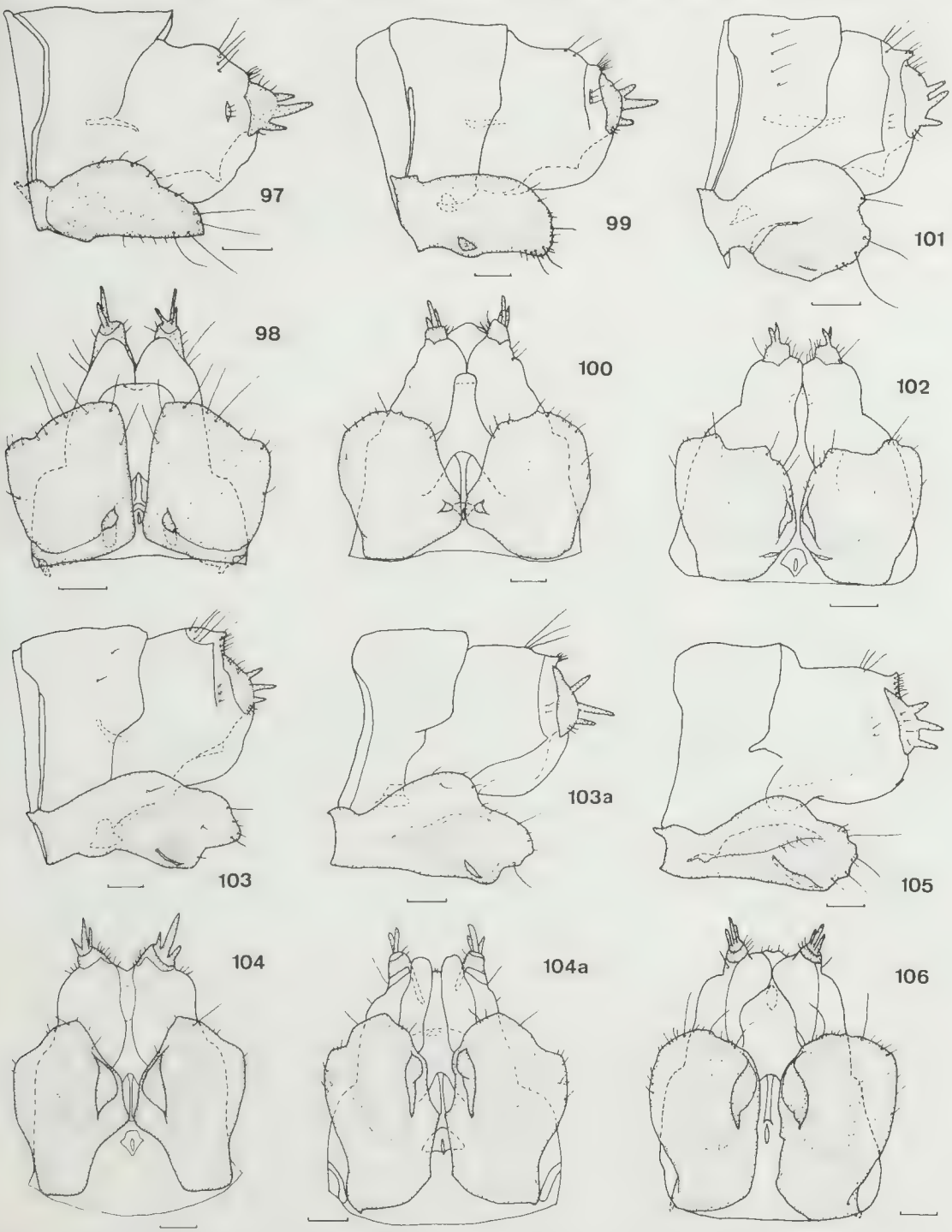
Scale lines: all 0.1 mm.



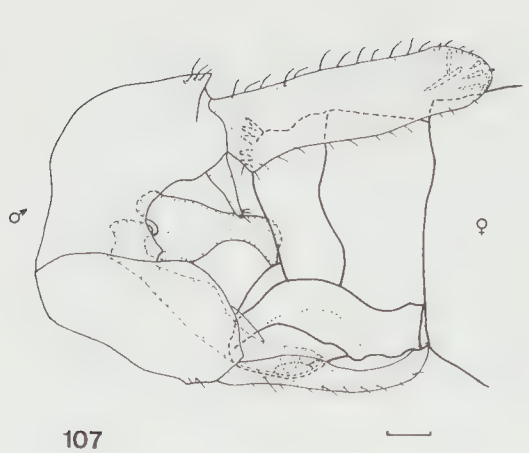
Figures 77–84. *Ecnomus* spp. Genitalia.
77, 78. *Ecnomus larakia* sp. nov., paratype male, N-NT. (CT-072): 77, lateral view; 78, ventral view.
79, 80. *Ecnomus pakadji* sp. nov., holotype male, NE-Qld. (CT-052): 79, lateral view; 80, ventral view.
81, 82. *Ecnomus walajandari* sp. nov., paratype male, N-WA. (CT-065): 81, lateral view; 82, ventral view.
83–84. *Ecnomus russellius* Neboiss, Tas. (CT-108), female: 83, lateral view; 84, ventral view; v.pl., ventral plate.
Scale lines: all 0.1 mm.



Figures 85–96. *Ecnomus* spp. Female genitalia.
85, 86. *Ecnomus myallensis* sp. nov., Vic. (CT-087): 85, lateral view; 86, ventral view.
87, 88. *Ecnomus pansus* Neboiss, S-WA. (CT-114): 87, lateral view; 88, ventral view.
89, 90. *Ecnomus cygnitus* Neboiss, Vic. (CT-096): 89, lateral view; 90, ventral view.
91, 92. *Ecnomus tridigitus* sp. nov., paratype, NE-NSW. (CT-099): 91, lateral view; 92, ventral view.
93, 94. *Ecnomus continentalis* Ulmer, NE-Qld. (CT-106): 93, lateral view; 94, ventral view.
95, 96. *Ecnomus nibbor* sp. nov., paratype, Vic. (CT-104): 95, lateral view; 96, ventral view.
Scale lines: all 0.1 mm.



Figures 97–106. *Ecnomus* spp. Female genitalia.
97, 98. *Ecnomus turgidus* Neboiss, paratype, S-WA. (CT-113): 97, lateral view; 98, ventral view.
99, -100. *Ecnomus deani* sp. nov., SE-NSW. (CT-110): 99, lateral view; 100, ventral view.
101, 102. *Ecnomus wellsae* sp. nov., paratype, NE-NSW. (CT-097): 101, lateral view; 102, ventral view.
103, 104. *Ecnomus tillyardi* Mosely, Tas. (CT-107): 103, lateral view; 104, ventral view.
103a, 104a. *Ecnomus tillyardi* Mosely (variety) E-Vic. (CT-109): 103a, lateral view; 104a, ventral view.
105, 106. *Ecnomus volsellus* sp. nov., paratype, Vic. (CT-092): 105, lateral view; 106, ventral view.
Scale lines: all 0.1 mm.



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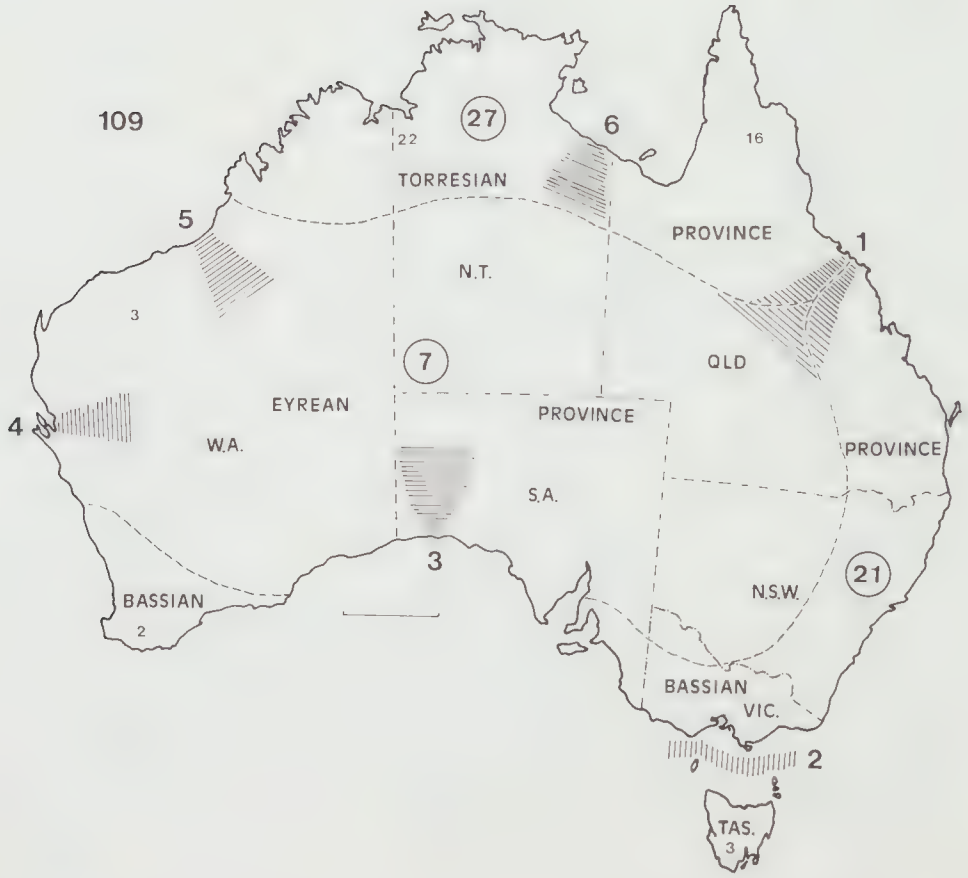
108



Figures 107–109.

107, 108. *Ecnomus tillyardi* Mosely (variety), male and female in copula, Vic. (CT-093): 107, lateral view; 108, ventral view. 109, faunal provinces of Australia, with associated barriers or disjunctions (////), total number of species of *Ecnomus* in each province indicated by Ⓝ, number of species of *Ecnomus* in each region (between barriers) indicated by N.

Scale lines: figs 107, 108, 0.1 mm; fig. 109, 500 km.

Figures 110, 111. Distribution of *Ecnomus* species.

110, *Ecnomus ingibandi* sp. nov. (■); *Ecnomus kitabal* sp. nov. (▽); *Ecnomus jimba* sp. nov. (▲); *Ecnomus turgidus* Neboiss (●).

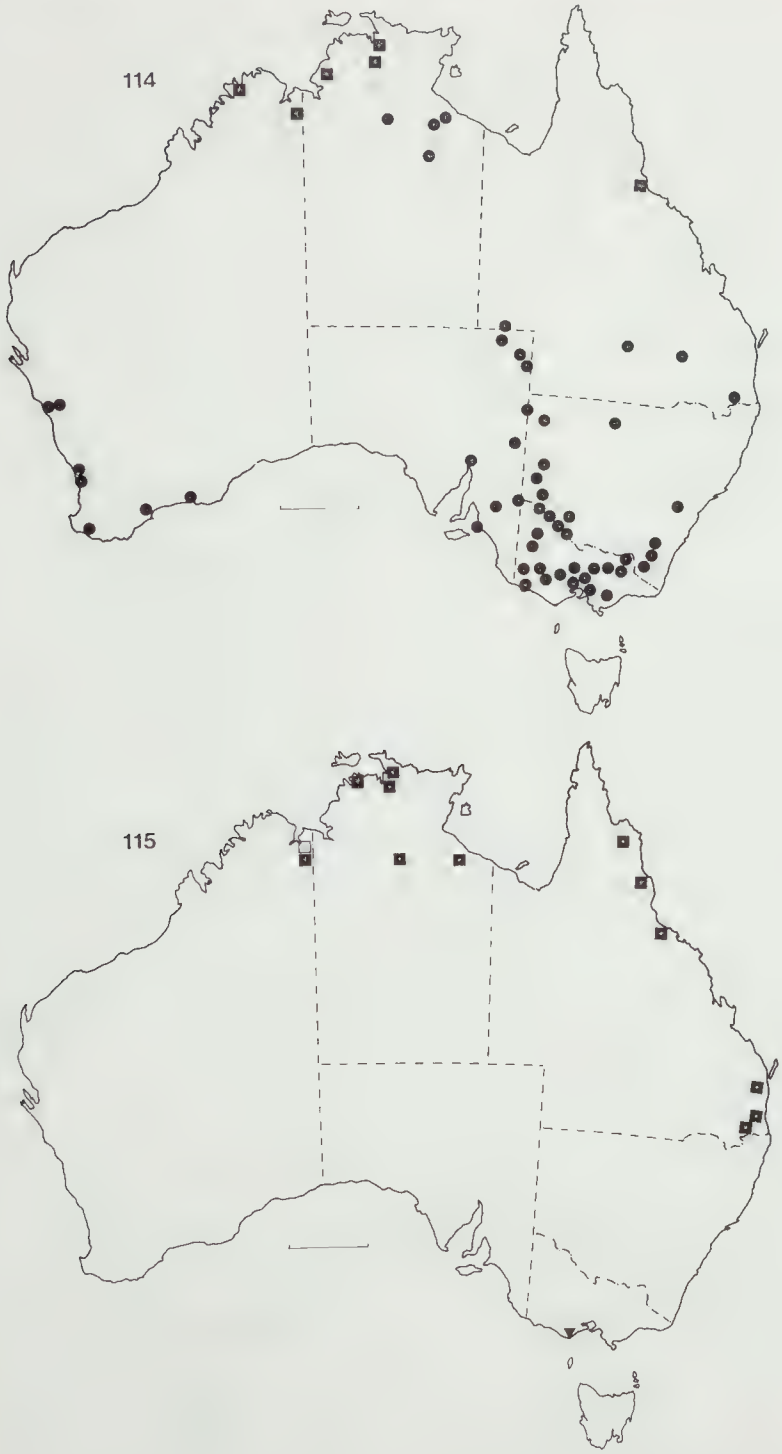
111, *Ecnomus veratus* sp. nov. (■); *Ecnomus tridigitus* sp. nov. (●); *Ecnomus neboissi* sp. nov. (○); *Ecnomus turrbal* sp. nov. (▲).

Scale lines: all 500 km.

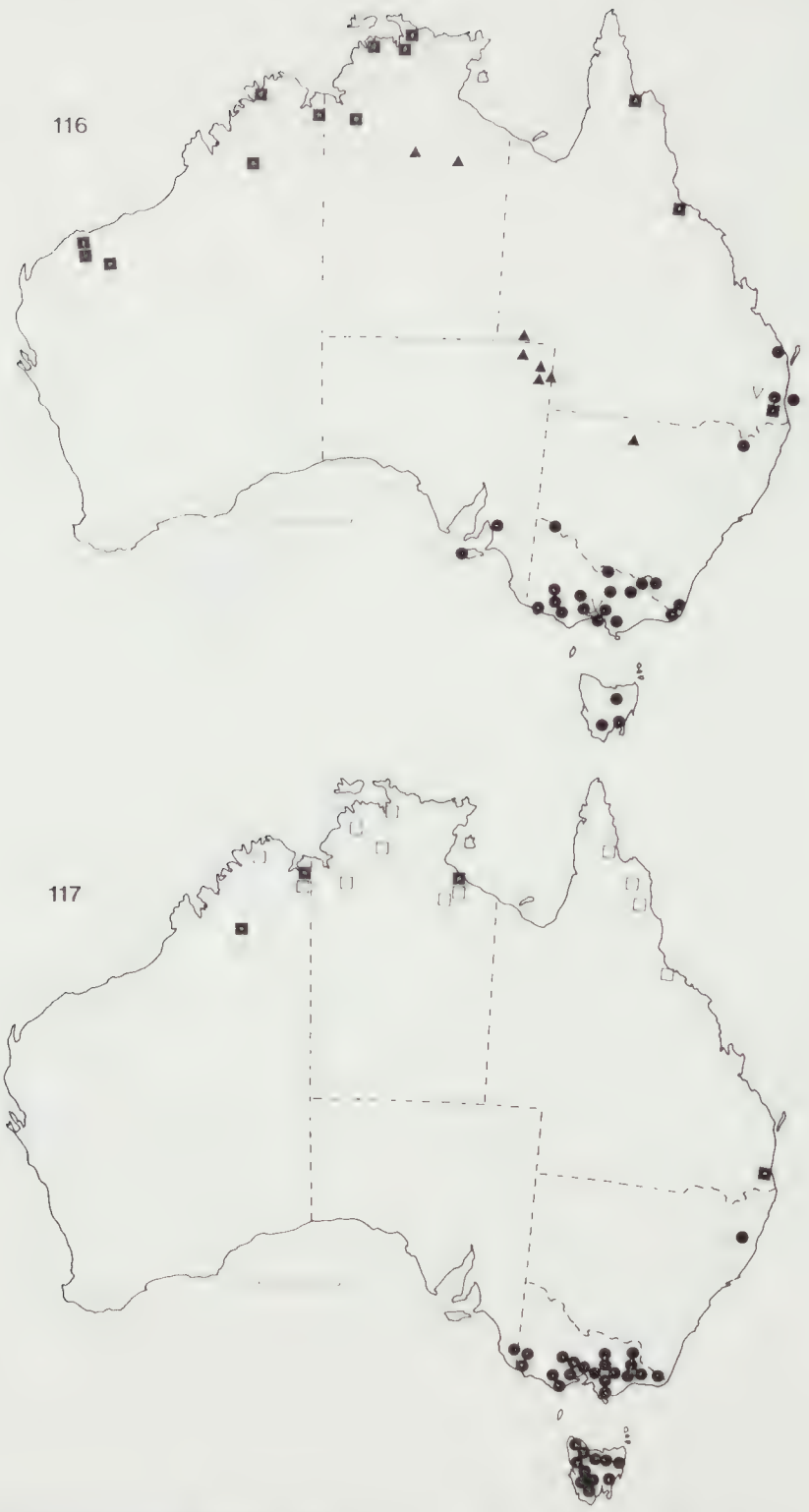
Figures 112, 113. Distribution of *Ecnomus* species.

112, *Ecnomus digrutus* sp. nov. (△); *Ecnomus volsellus* sp. nov. (●); *Ecnomus larakia* sp. nov. (■); *Ecnomus pakadji* sp. nov. (▼); 113, *Ecnomus kakaduensis* sp. nov. (■); *Ecnomus wellsae* sp. nov. (▲); *Ecnomus deani* sp. nov. (●); *Ecnomus miriwud* sp. nov. (□).

Scale lines: all 500 km.



Figures 114, 115. Distribution of *Ecnomus* species.
114, *Ecnomus wororan* sp. nov. (■); *Ecnomus pansus* Neboiss (●).
115, *Ecnomus cuspidis* sp. nov. (■); *Ecnomus karakoi* sp. nov. (▼); *Ecnomus bishopi* sp. nov. (□).
Scale lines: all 500 km.

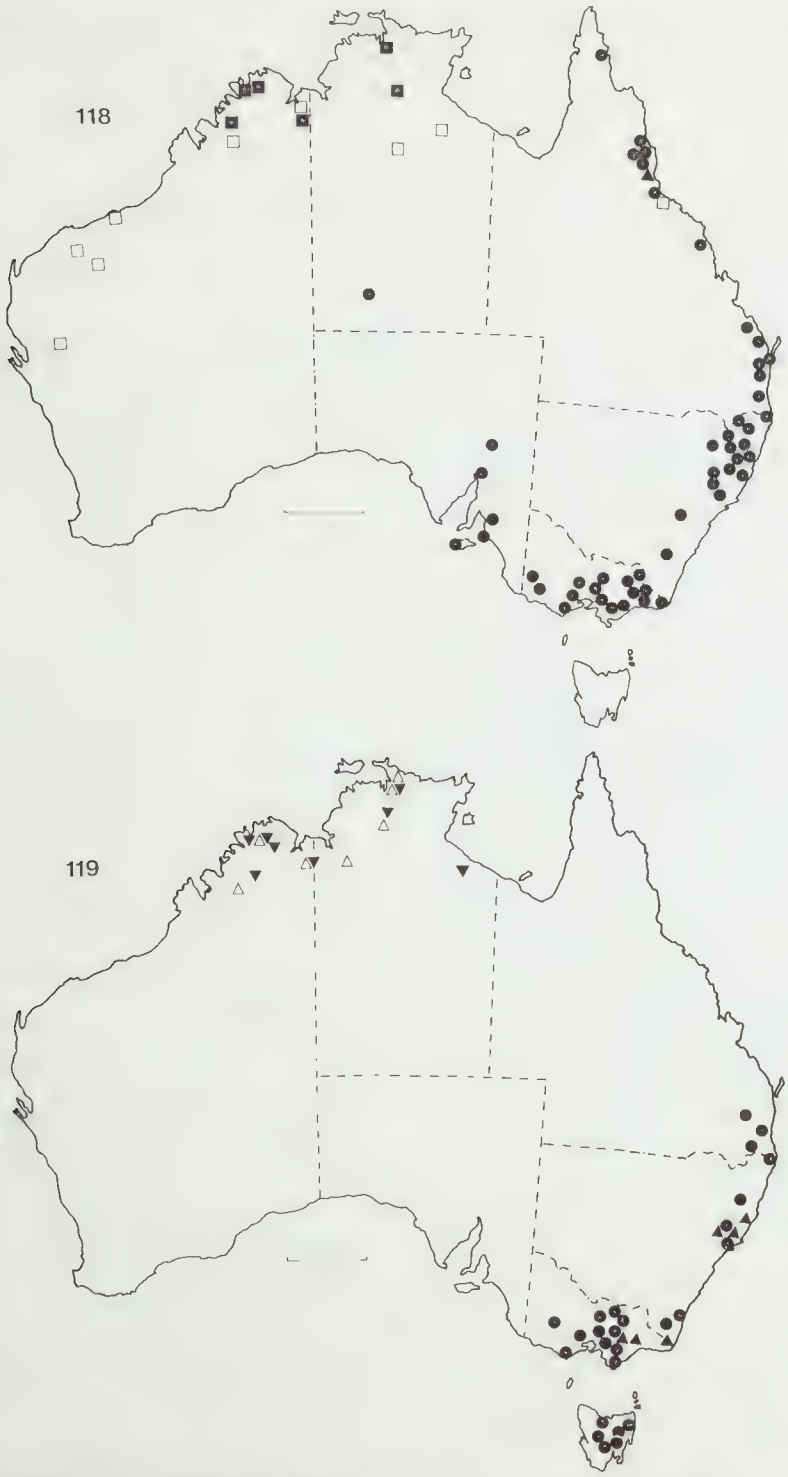


Figures 116, 117. Distribution of *Ecnomus* species.

116, *Ecnomus clavatus* sp. nov. (◙); *Ecnomus cygnitus* Neboiss (●); *Ecnomus centralis* sp. nov. (▲); *Ecnomus myallensis* sp. nov. (▽).

117, *Ecnomus tillyardi* Mosely (●); *Ecnomus apiculatus* sp. nov. (■); *Ecnomus kinka* sp. nov. (□).

Scale lines: all 500 km.



Figures 118, 119. Distribution of *Ecnomus* species.

118, *Ecnomus kerema* sp. nov. (▲); *Ecnomus continentalis* Ulmer (●); *Ecnomus ancisus* sp. nov. (◘); *Ecnomus pilbarensis* sp. nov. (□).

119, *Ecnomus nibbor* sp. nov. (▲); *Ecnomus blythi* sp. nov. (△); *Ecnomus yabbura* sp. nov. (▼); *Ecnomus russellius* Neboiss (●).

Scale lines: all 500 km.

Figure 120. Distribution of *Ecnomus* species. *Ecnomus wagengugurra* sp. nov. (○); *Ecnomus karawalla* sp. nov. (●); *Ecnomus tropicus* sp. nov. (▲); *Ecnomus walajandari* sp. nov. (▼). Scale line: 500 km.

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DESCRIPTION OF THE IMMATURE STAGES AND THE ADULT MALE OF AN AUSTRALIAN MEALYBUG, MELANOCOCCUS ALBIZZIAE (MASKELL) (COCCOIDEA: PSEUDOCOCCIDAE)

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Abstract

Farrell, G.S., 1990. Description of the immature stages and the adult male of an Australian mealybug, *Melanococcus albizziae* (Maskell) (Coccoidea: Pseudococcidae). *Memoirs of the Museum of Victoria* 51(1): 49–64.

All instars of *Melanococcus albizziae* (Maskell) except for the adult female are described and illustrated. Characteristic features of each instar and of the species, including the incidence and form of the dorsal cerarii in nymphal instars, are discussed. The morphology of the adult male is examined in detail and compared with that of other species of the family.

Introduction

The taxonomy of Australian scale insects is generally poorly understood, in spite of the early interest of such workers as W.M. Maskell and the recognition that Australia is apparently the origin of many species of economic importance. However Williams' (1985) revision of the Australian Pseudococcidae based on the adult female stage has elucidated many of the historical problems of the family in this country. This treatment has provided a sound basis for an understanding of the group within Australia, but there is still an urgent need for more detailed descriptions and illustrations of the pre-adult instars and where possible the adult male.

The mealybug *Melanococcus albizziae* (Maskell) is found along the eastern coast of Australia, occurring predominantly on *Acacia* Willd. (Mimosaceae). It was thought to be restricted to this host-plant genus, there being doubt concerning earlier host-plant records on other genera (Williams, 1985). However the host-plant range of this mealybug must be reconsidered again as a breeding population of the species has recently been found on *Albizzia lophantha* (Willd.) in Victoria (Farrell, unpublished data). This is the first record of the mealybug on this host-plant since the species' original collection. *M. albizziae* is polyphagous on *Acacia* (Farrell, 1985; Williams, 1985), and is one of the few Australian mealybugs capable of inflicting damage on its native hosts (Williams, 1985). French (1916) reported death of the host-plant if an infestation was left unchecked. In Victoria the mealybug has been observed to attain locally high population levels, although only one individual host-plant has been observed to have died and it was not possible to attribute cause of death solely to the infestation (Farrell, 1985). However the level of damage attributable to sublethal, high density infestations is as yet unquantified.

While studying the ecology of this mealybug in southern Victoria, sufficient numbers of all instars of both sexes were collected to allow detailed description of the species. As Williams (1985) has provided details of the adult female, the descriptions presented here will be limited to the other stages of development.

Materials and methods

All material was collected in the Melbourne area (Farrell, 1985). Samples thought to contain males were returned to the laboratory to enable rearing of the adult males while all other material was used immediately to make slides or stored in 70% ethanol. Preparation of material for slide-mounting varied depending on the stage of the mealybug being examined. Small and delicate material such as early instars of both sexes and all pre-adult instars of the male were prepared using the techniques of Afifi and Kosztarab (1967), while later instars of the female were prepared using the techniques of Banks and Williams (1972). All stages were stained with acid fuschin and mounted in Euparal. Diagrams were produced using a camera lucida attached to a Zeiss compound micro-

scope. Illustrations (except for adult male) include a central drawing of the insect with the left half representing the dorsal aspect and the right half the ventral aspect. Enlargements of important details are placed around the perimeter of the figure. These enlargements are not to the same scale in each illustration, nor are the dermal structures and enlargements in direct proportion to each other. Scale lines are for the central drawing only, the exception to this being the illustration of the adult male. Details of the adult male illustration are provided in the figure legend. All measurements of morphological characters are in micrometers and are given either as ranges or as means followed by ranges in parentheses. Were possible a minimum of ten replicates were used for each character. Terminology for females instars is based on Williams (1985) and for males instars on Afifi (1968). Voucher specimens of each stage described here and of the adult female, have been lodged in the Australian National Insect Collection, Canberra.

Melanococcus Williams

Melanococcus Williams, 1985: 203.

Type species. Dactylopius albizziae Maskell, 1892: 31.

Remarks. This genus was erected for 11 species of Australian mealybugs found on *Acacia*. Although close in character to two other genera, *Epicoccus* Cockerell and *Mutabilicoccus* Williams, the species of *Melanococcus* form a natural group if all characters are considered (Williams, 1985). In life the mealybugs are a dark reddish-brown to black with a flocculent ovisac beneath the body of the adult. The body itself is often shiny and usually without a covering (Williams, 1985). Important characteristics of the genus include the structure of the anal ring and anal lobes, the type of setae found on the derm, particularly the similarity between cerarian and dorsal setae, the presence of an anal bar and the presence of tubular ducts around the ventral margins. Also the cerarii are restricted to the last few abdominal segments, trilocular pores and ostioles are present and the circulus and multilocular pores are variable in their occurrence (Williams, 1985).

Melanococcus albizziae (Maskell)

Dactylopius albizziae Maskell, 1892: 31. — Lidgett, 1899: 54. — Froggatt, 1916: 814.
Dactylopius acaciae Maskell, 1892: 23. — Lidgett, 1899: 53. — Froggatt, 1916: 813.
Pseudococcus albizziae. — Fernald, 1903: 97.
Pseudococcus acaciae. — Fernald, 1903: 97.
Melanococcus albizziae. — Williams, 1985: 205.

First Instar (Fig. 1). Body ovoid, dorsoventrally flattened, naked and dark red in colour before leaving brood chamber; after settling becoming less dorsoventrally flattened, cigar shaped, covered with light dusting of waxy white powder. Legs and antennae large with respect to body. Slide-mounted specimens 473 (438–538) long, 248 (200–235) wide.

Dorsum: Cerarii arranged in a marginal series of 18 pairs. Anal lobe cerarii (Fig. 1A), of 2 conical setae, no auxiliary setae and a single trilocular pore within a lightly sclerotized area. Remaining cerarii (Fig. 1B), also made up of 2 conical setae and a trilocular pore, but setae indistinguishable from body setae and not associated with a sclerotized area. Dorsal body setae long and slender, few in number, arranged as follows: abdominal segments I to VII each medially with a pair of cerarian-like setae associated with a pair of trilocular pores, position of pores variable (Fig. 1C, D, E) and each side of segment with a submarginal seta associated with a trilocular pore except segments I, II where 2 pores per seta may occur; thorax: mesothorax and metathorax with transverse rows of setae apparently associated with each segment, the setae grouped medial and submarginal and each seta with a trilocular pore; prothorax and head variable, but usually 1 or both with a pair of medial setae with trilocular pores, prothorax occasionally with a submarginal seta and associated pore on each side. Pair of trilocular pores on abdominal segment VIII. Oral rim and oral collar ducts and multilocular pores absent. Anal ring (Fig. 1F) entire, with 6 setae. Abdominal ostioles present.

Venter: Anal lobe: anal bar with a long slender seta (Fig. 1G); apical setae robust, 84–102 long. Two pairs of long setae on abdomen segment IX ventral to anal ring. Ventral body setae (Fig. 1I), longer and more slender than dorsal body setae, anterior setae (Fig. 1J), longer than posterior setae; setae arranged as follows: on abdominal segments III to VII each side of body with a double row of submedial setae and a row of submarginal setae; submedial setae on segment VII with trilocular pore; submarginal setae with minute circular pore (Fig. 1H); abdominal segment II and III with a single row of submedial setae; mesothorax with a pair of setae and a trilocular pore between mid and hind legs and a pair of setae near labium; head with 6 to 8 setae between antennae. Microspines on all abdominal seg-

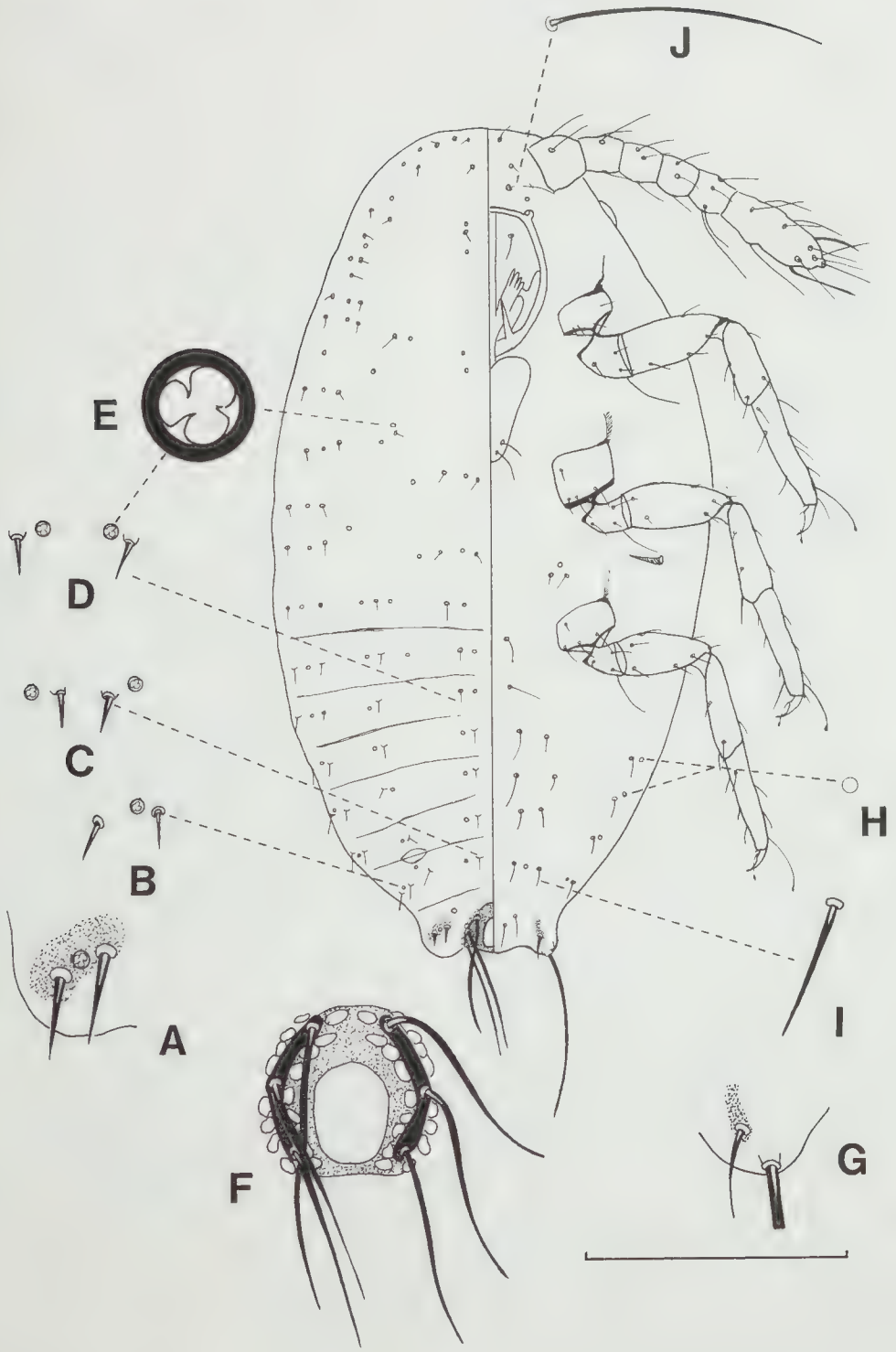

Figure 1. First instar *Melanococcus albizziae*. (See Appendix for abbreviations in this and all other figures. All scale lines 150 μm long.)

ments and most thoracic segments. Oral rim and oral collar ducts and multilocular pores absent. Circulus indistinct. Antennae with 6 segments, 170 (160–181, n = 14) long; terminal segment longest. Legs large compared to body and well developed; tarsal and claw digitules slender with knobbed apex. Length of hind femur: 58 (54–65 n = 19).

Second Instar (Fig. 2). Live specimens dark red to dark purple in colour, usually covered with a white waxy exudate. Cigar shaped, similar to settled first instar. Antennae and legs hidden under body. Slide-mounted specimens 819 (688–925) long, 468 (325–600) wide.

Dorsum: Cerarii restricted to abdominal segments. Anal lobe cerarii (Fig. 2A), formed of 2 conical setae, 1 auxiliary seta and 3–4 trilocular pores within a sclerotized area. Remaining cerarii (Fig. 2B), on segments IV to VII, occasionally segment III consisting of 2 conical spines more slender than anal lobe setae and a number of trilocular pores; cerarian setae becoming indistinguishable from body setae anteriorly. Dorsal body setae of 2 types: long spiny setae resembling cerarian setae (Fig. 2C), and shorter, more slender setae (Fig. 2D); arranged as follows: on abdominal segments I to VII in transverse rows and longitudinally into medial bands resembling dorsal cerarii, consisting of 3 setae and associated trilocular pores per segment. (Fig. 2C), setae becoming less closely grouped anteriorly; remaining setae on abdomen in band between medial setae and cerarii, consisting predominantly of cerarian-like setae with some smaller setae (Fig. 2D); on thorax in 2 transverse rows corresponding to position of mesothorax and metathorax with some setae scattered on remainder of thorax and head. Trilocular pores (Fig. 2E), present on head and thorax, associated with setae; abdominal segment VIII with a transverse row of 6 trilocular pores. Oral collar ducts occasionally present on abdomen submarginally. Oral rim and multilocular pores absent. Anal ring (Fig. 2F), entire, bearing 6 setae, 66–84 long. Cephalic and abdominal ostioles poorly defined; with setae and trilocular pores on outer lips.

Venter: Anal lobe (Fig. 2G) with anal bar bearing a long slender seta; apical setae 90–160 long, with a short seta and trilocular pore anterior to each apical seta. Two pairs of long setae on abdomen segment IX ventral to anal ring. Ventral body setae (Fig. 2H), longer and more slender than dorsal setae, anterior setae (Fig. 2I), longer than posterior setae; setae arranged on abdomen as follows: a double submedial row and a double submarginal row on segments III to VII; segment II and III with a pair of setae medially, submarginal setae variable; some abdominal segments occasionally with shorter setae distal to submarginal setae; body setae on thorax and head scattered randomly, but most numerous between antennae on head. Trilocular pores on abdomen near setae; on thorax near setae but also near spiracles and submarginally; on head randomly distributed. Microspines on all abdominal segments and most thoracic segments. Oral collar ducts (Fig. 2J) on abdomen submarginally, rarely on thorax. Oral rim pores absent. Circulus indistinct (Fig. 2K). Multilocular pores (Fig. 2L), associated with intercoxal setae on thorax. Antennae with 6 segments (Fig. 2M), 202 (178–218, n = 12) long; terminal segment longest. Legs well developed; tarsal and claw digitules slender with knobbed apex. Length of hind femur: 82 (69–90, n = 19).

Third Instar (*Female*) (Fig. 3). Live specimens dark red, covered with a white waxy exudate. Body elliptical, more rotund than previous stages. Antennae and legs hidden under body. Slide-mounted specimens 1250 (1017–1488) long, 820 (589–973) wide.

Dorsum: Cerarii restricted to abdominal segments. Anal lobe cerarii (Fig. 3A), formed of 2 conical setae, 2 or 3 setae similar to, but smaller than, cerarian setae, 2 or 3 auxiliary setae and a group of 6–9 trilocular pores; area lightly sclerotized, irregularly shaped. Remaining cerarii (Fig. 3B), on segments IV to VII, occasionally segment III, consisting of 2 conical spines more slender than anal lobe setae and a number of trilocular pores; cerarian setae becoming indistinguishable from body setae anteriorly. Body setae of 2 types: longer setae, resembling cerarian setae (Fig. 3C), and indistinguishable from anterior cerarian setae and shorter, more slender setae; longer setae arranged as follows: in transverse rows on abdominal segments I to VII, each segment having a medial group of 3 setae and associated trilocular pores resembling dorsal cerarii (Fig. 3C), medial setae becoming more slender and less closely grouped anteriorly; thorax and head predominantly with cerarian-like setae scattered in clumps. Shorter body setae scattered over body. Trilocular pores (Fig. 3D), in transverse rows on abdomen; scattered over thorax and head, but tending to be near setae. Minute circular pores (Fig. 3E), scattered on thorax. Oral collar and oral rim ducts and multilocular pores absent. Anal ring (Fig. 3F), entire, bearing 6 setae, 78–102 long. Cephalic ostioles faint and abdominal ostioles poorly defined, but

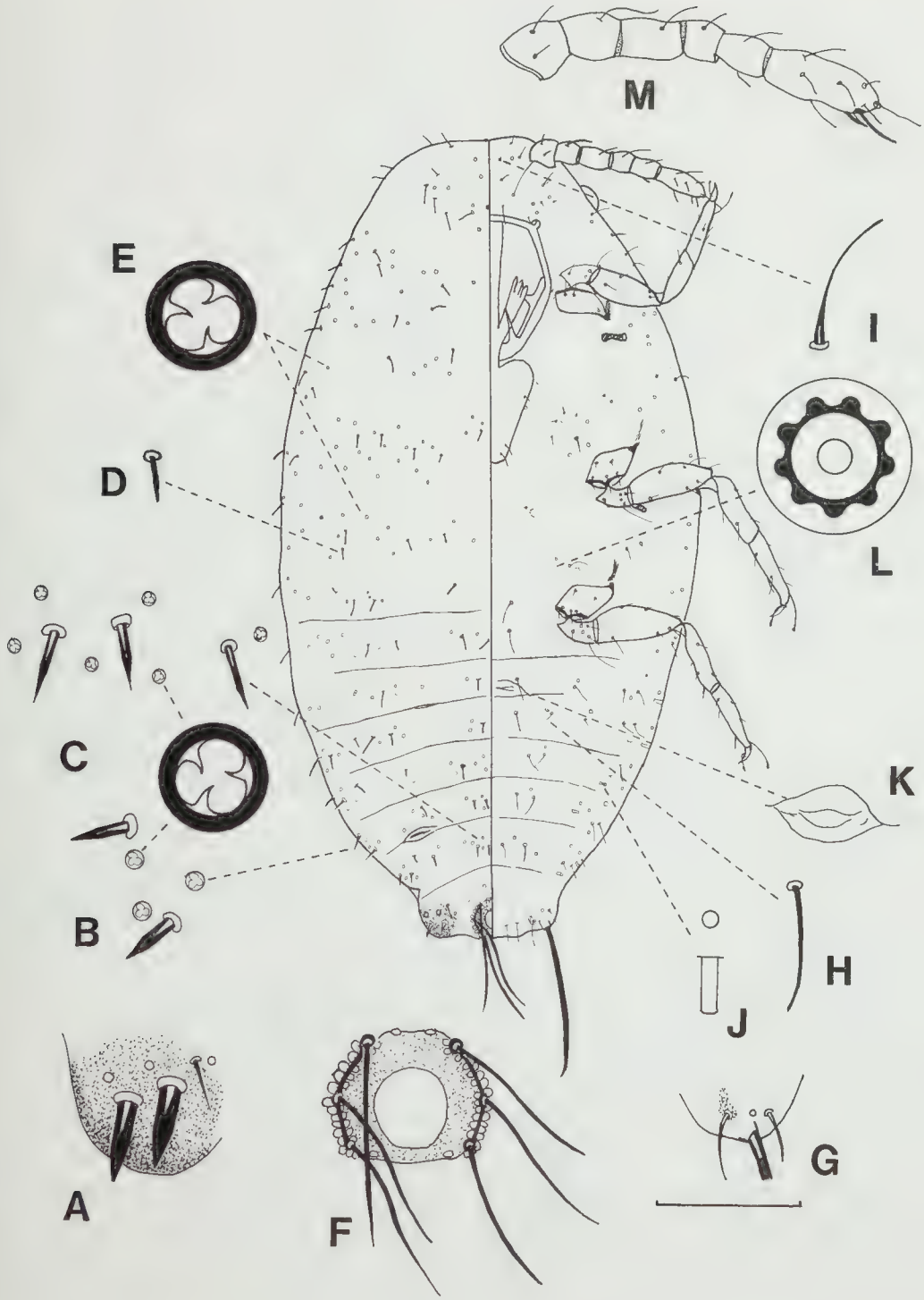

Figure 2. Second instar *Melanococcus albizziae.*

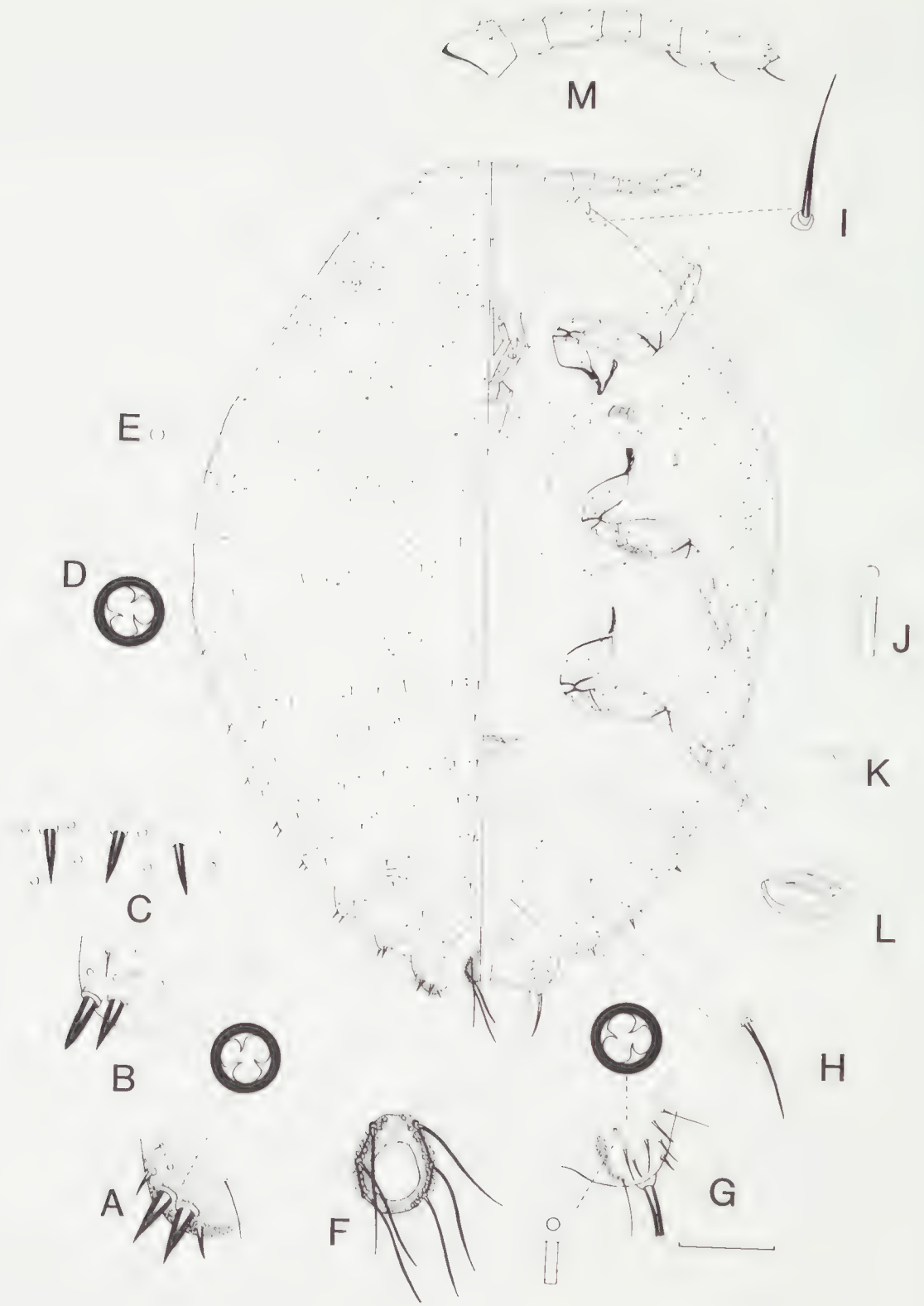

Figure 3. Third instar female *Melanococcus albizziae*.

more distinct; both with setae and trilocular pores on outer lips.

Venter: Anal lobe (Fig. 3G), with anal bar bearing a long slender seta; apical setae robust 132–156 long; 3 to 4 trilocular pores, several oral collar ducts and 4 to 6 auxiliary setae also on anal lobe. Three pairs of long setae on abdomen segment IX ventral to anal ring. Ventral body setae (Fig. 3H), longer and more slender than dorsal setae, anterior setae (Fig. 3I), longer than posterior setae; setae on abdomen in transverse rows; on thorax, submarginally and between legs; on head between antennae. Trilocular pores numerous submarginally on abdomen and thorax, around spiracles and associated with body setae between coxae; less numerous medially on abdomen and head. Microspines absent. Oral collar ducts (Fig. 3J) scattered submarginally on abdomen, submarginally and medially on thorax. Oral rim ducts absent. Minute circular pores (Fig. 3K), scattered over venter, usually associated with setae. Circulus indistinct (Fig. 3L). Multilocular pores rarely present. Antennae with 6 segments (Fig. 3M), 235 (223–258, n = 11) long, terminal segment longest. Legs well developed; tarsal and claw digitules slender with knobbed apex. Length of hind femur: 89 (81–102, n = 18).

Third Instar (*Male*) (Fig. 4) In life red in colour, body elongate, wing pads small; often covered by fluffy white wax test. Slide-mounted specimens 1068 (992–1116) long, 512 (485–576) wide.

Dorsum: Lateral margin of abdominal segments IV to VII, and occasionally segments II and III, each with 2–3 marginal setae grouped together and often near oral rim ducts. (Fig. 4A). Segment VIII with 3 setae (Fig. 4B), in a transverse row on lateral margin. Marginal setae occasionally occuring on thorax. Body setae similar to marginal setae, as follows: in transverse rows on abdominal segments II to VII, each segment having a medial group of 3 setae (Fig. 4C); on thorax (Fig. 4D), setae scattered on metathorax and prothorax, absent or rare on mesothorax; on head concentrated anteromedially. Trilocular pores absent. Multilocular pores (Fig. 4E) in irregular transverse rows on abdomen, scattered over thorax and head, but mainly associated with setae. Oral rim ducts (Fig. 4F), common on abdomen, but less frequent on thorax and head. Oral collar ducts absent. Hamulohalteres not apparent. Wing buds 119 (84–150) long, 115 (102–120) wide. Abdominal ostioles present. Genital segment: penial sheath with microspines; anal opening dorsal; apically 2 pairs of setae. Sheath 63 (54–78) long, 97 (84–108) wide.

Venter: Segment VIII (Fig. 4G), with apical setae 69–102 long and 2 shorter auxiliary setae. Ventral body setae (Fig. 4H), shorter than dorsal body setae; in transverse rows on abdomen, scattered over thorax; setae on head between antennae, longer. Multilocular pores (Fig. 4I), in transverse rows on abdomen, generally scattered on thorax but concentrated around spiracles, rare on head. Oral rim ducts (Fig. 4J), scattered on abdomen marginally; on thorax usually near spiracles and marginally on mesothorax. Oral collar ducts absent. Antennal segments often partly fused, segmentation variable; total length 233 (216–294). Legs developed, with short setae; tibiotarsal articulation absent. Length of hind femur: 108 (99–118, n = 11).

Fourth Instar (*Male*) (Fig. 5). In life red in colour, body elongate, wing pads well developed; antennae long; body often covered by fluffy text of white waxy threads. Slide-mounted specimens 1142 (992–1240) long, 434 (359–484) wide.

Dorsum: Lateral margin of each abdominal segment II to VII with 2-3 setae (Fig. 5A), in cluster resembling cerarii; with associated oral rim ducts. Abdominal segment VIII with a submarginal transverse row of 3 setae (Fig. 5B), similar to other submarginal abdominal setae, but not associated with oral rim ducts. Body setae similar to marginal setae, arranged as follows: in transverse rows on abdominal segments II to VII, each segment with medial group of 3 setae similar to dorsal cerarii (Fig. 5C); on thorax in a single row and clustered at base of wing bud of mesothorax, in transverse row and submarginally on prothorax; scattered over head. Trilocular pores absent. Multilocular pores (Fig. 5D) in transverse rows on abdominal segments III to VII; on thorax, near metathoracic body setae (Fig. 5E). Oral rim ducts (Fig. 5F), near abdominal cerarian-like submarginal setae; on prothorax submarginally. Oral collar ducts absent. Postocular ridge present; dorsal portion of ocular sclerite weakly sclerotized. Hamulohalteres not apparent. Wing buds 404 (311–516) long, 114 (68–141) wide. Abdominal ostioles present. Genital segment: penial sheath with microspines; anal opening dorsal; 2 pairs of setae apically. Sheath 74 (69–84) long, 101 (90–108) wide.

Venter: Segment VIII (Fig. 5G), with apical setae 75–102 long and 2 shorter auxiliary setae. Ventral body setae (Fig. 5H), shorter than dorsal

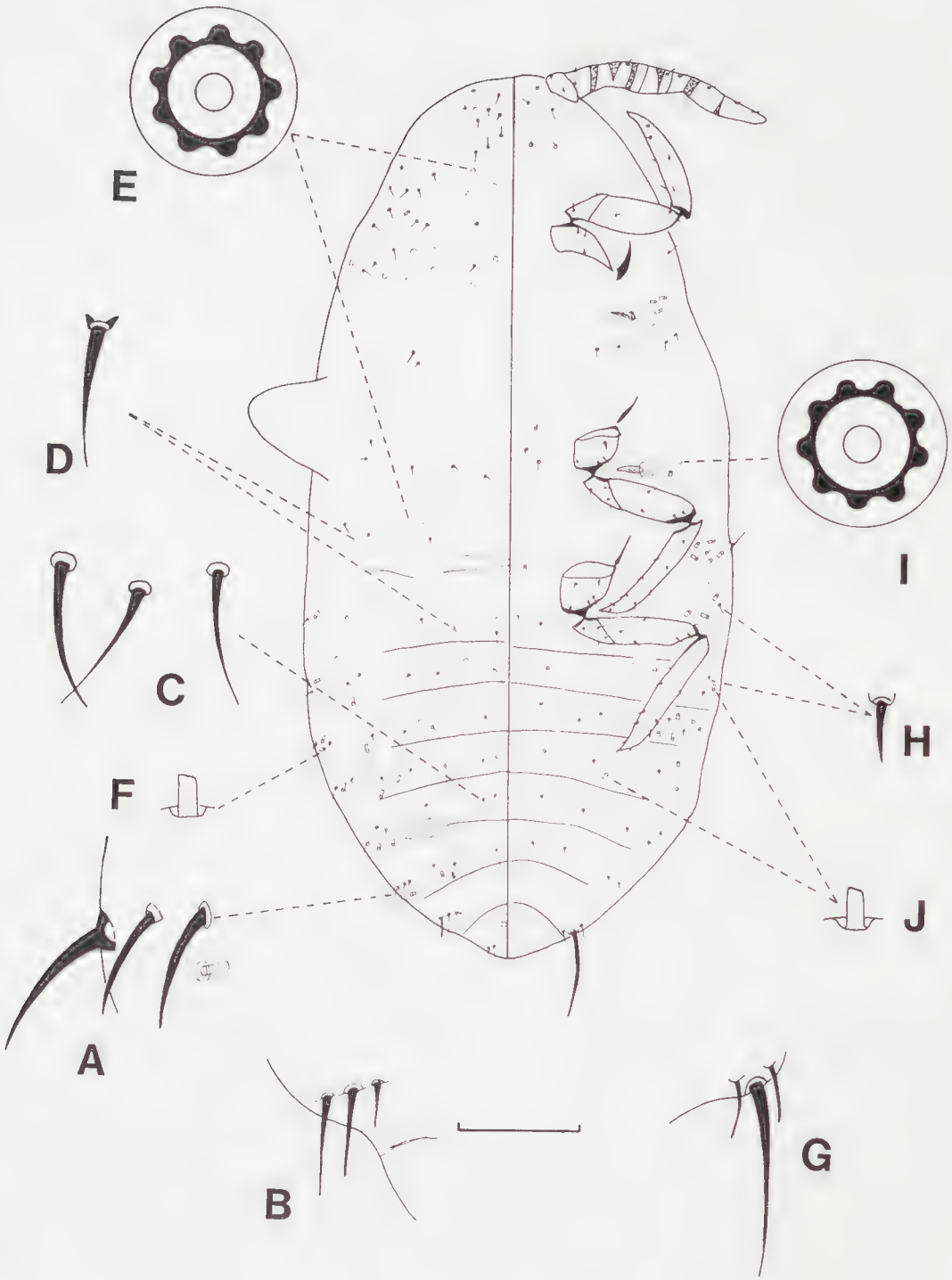

Figure 4. Third instar male *Melanococcus albizziae*.

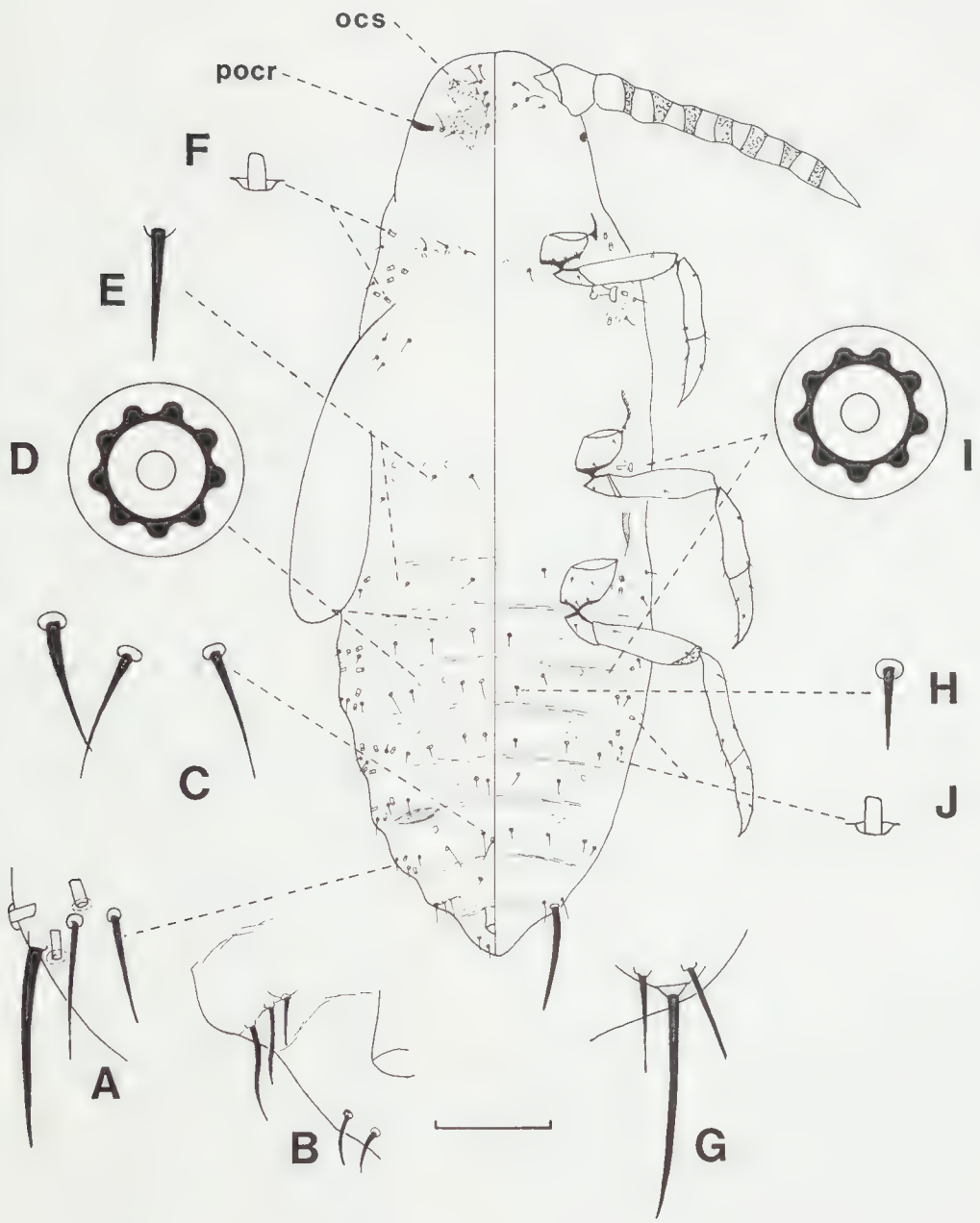

Figure 5. Fourth instar male *Melanococcus albizziae.*

body setae; in transverse rows on abdomen; densest around spiracles on thorax with occasional seta associated with coxa; setae longer on head, between antennae. Multilocular pores (Fig. 5I), in clusters on abdominal segments II to VIII; on thorax near spiracles and between fore coxa. Oral rim ducts (Fig. 5J), on lateral margins of abdominal segments II to VII; rare on thorax and head. Oral collar ducts absent. Antennal segments well developed, 9 segmented, 411 (375–447, n = 7) long; apical segment longest. Legs well developed; with tibiotarsal articulation and setae. Length of hind femur: 136 (123–141, n = 9).

Fifth Instar (*Adult Male*) (Fig. 6) In life red in colour, body slender, narrow; wings, antennae moderately sized compared with body. Slide-mounted specimens 1080 (1030–1184) long, 278 (225–338) wide; wing span 2338 (1183–1426).

Head: Subtetrahedral; subtriangular in dorsal and anterior view (Fig. 6A,C); ventral preocular depression not apparent in lateral view (Fig. 6B). Length 177 (125–192), width 206 (190–225). Dorsal arms of midcranial ridge anteriorly detached from other arms (Fig. 6C), posteriorly meeting postocular ridge; ventral and lateral arms forming Y-shaped ridge, ventral ridge poorly defined, reduced to slender line surrounded by irregular sclerotized area (Fig. 6C). Postocular ridge U-shaped, discontinuous with preocular ridge anteriorly; thickest posteriorly, tapering anteriorly and terminating at preocular ridge; posterior edge of ridge lightly sclerotized. Preocular ridge and interocular ridge joined posteriorly to postocular ridge below ocellus. Preoral ridge slender. Eyes: dorsal simple eyes with corneae 25.8 (22.5–35.0) in diameter, ventral simple eyes with corneae 25.3 (22.5–32.5) in diameter. Lateral ocelli large. Cranial apophysis truncated apically. Tentorial bridge very slender. Dorsal setae: 8–13 on each side of midline. Genial setae: 2–3 on each side of midline. Ventral head setae: 3–8 between ventral simple eyes; 19–22 in a transverse band across area of ventral preocular depression; 5–7 associated with lateral arms of midcranial ridge. Head disc pores (Fig. 6E): 1 pore associated with base of antennae.

Antennae: Filiform, 10-segmented, 683 (633–718) long; longer than half body ratio (ratio 1:1.30–1.71, average 1.58) and slightly longer than hind leg (ratio 1 : 1.08–1.23, average 1.17). Size of segments given in Table 1. Scape with 4 hair-like setae. Pedicel and flagellum with

Table 1. Length and width of antennal segments of adult male *Melanococcus albizziae*.

	Segment (μm)									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Length										
range	37.2–48.0	54.0–69.0	69.0–93.0	69.0–88.8	63.0–87.6	66.0–90.0	60.0–78.0	61.8–72.0	48.0–66.0	60.0–78.0
mean	41.0	61.7	79.9	78.0	74.9	76.7	68.6	67.1	57.3	67.2
n	8	8	8	8	8	8	6	6	8	8
Width										
range	39.0–48.0	33.0–42.0	27.0–30.6	23.4–28.8	24.0–28.2	24.0–27.0	22.8–27.0	21.0–24.0	19.8–24.0	18.0–24.0
mean	44.1	38.5	27.8	25.8	25.7	25.0	24.8	23.5	22.6	20.4
n	8	8	8	8	8	8	6	6	8	8

Figure 6. Fifth instar male (adult) *Melanococcus albizziae*. A, dorsal and ventral aspects of body. B, lateral aspect of body. C, head, anterior view. D, 10th antennal segment, dorsal view. E, body pores. F, minute circular pores.

numerous fleshy setae. Apical segment (Fig. 6D), with 2 subapical sensory setae; 2 antennal bristles subapically; 1 apical hair-like seta. Pedicel with sensillum placodeum dorsally. Hair-like setae variable, at most 1-2 per segment.

Thorax. Prothorax: Pronotal ridge usually with medial interruption; lateral pronotal sclerites and post-tergites distinct. Proepisternum bound ventrally by ridge-like structure reaching pleural ridge. Remaining pleural structures normal for family. Prosternum subtriangular, bounded posteriorly by well developed prosternal ridge. Prothoracic setae on each side: 1–2 medial pronotal setae; post-tergal setae absent; lateral pronotal setae absent; 0–4 antespiracular dorsal setae; antespiracular ventral setae absent, 0–2 prosternal setae, occasionally with 1 seta on apex of sclerite. Prothoracic pore on each side: 0–1 medial pronotal pores; 0–1 lateral pronotal pores; 2–3 antespiracular dorsal pores; 0–1 prosternal pores.

Mesothorax: Prescutum 82 (65–95) long, 133 (122–150) wide. Prescutal ridge well developed, prescutal suture developed but indistinct medially. Scutum 115 (100–125) long, 207 (180–240) wide; with heavily anterolateral, posterolateral sclerotization, medial area with narrow longitudinal membranous band. Prealare and triangular plate well developed, prealar ridge distinct. Scutellum 66 (50–85) long, 122 (100–160) wide; scutoscutellar suture and inward fold of posterior margin of notum well developed; medial ridge variable, but often distinct longitudinally, dividing sclerite. Postalare with well separated anterior and posterior postalar ridges. Mesopleuron: mesopleural ridge interrupted above coxal articulation; basalare present. Other pleural structures typical for family. Mesosternum: basisternum 148 (122–170) long, 233 (180–268) wide. Marginal and precoxal ridges strong; furca well developed. Thoracic setae on each side: 2–5 prescutal setae; 3–7 scutal setae; 2–5 scutellar setae; 4–8 postmesostigmatal setae; 0–4 tegular setae. Basisternal setae: 11–33 over entire sclerite. Pores on each side: 1 postmesostigmatal pore; 2–3 mesospiracular pores.

Metathorax: Metapostnotal sclerites and metapostnotal ridge well developed. Pleural ridge with pleural apophysis. Episternum and epimeron distinct, precoxal ridge well developed, tending to anteriorly delineate episternum. Metasternal apophysis distinct but occasionally absent. Metathoracic setae on each side: 1–3 metatergal setae; 0–2 metapleural setae; 1–4 anterior metasternal setae; 1–2 posterior metasternal setae. Pores on each side: metatergal pores absent; 1–2 metaspiracular pores; 1 anterior metasternal pore; 0–1 posterior metasternal pores.

Wings: 1031 (928–1088) long, 417 (371–454) wide. Alar lobe: additional sclerites developed; first and second auxiliary sclerites well developed, third auxiliary sclerite difficult to detect. Usually 3 alar setae, 2 circular sensoria. Hamulohalteres present; with 1 apical seta.

Legs: Of moderate length and slender (Table 2). All segments with numerous hair-like setae. Tarsus with 2 tarsal digitules, ungual digitules on claw absent. Trochanter with 2–3 circular sensilla on each side and 1 long apical seta. Tibia with 2 apical spurs and 2 smaller spine-like hairs.

Abdomen: 557 (487–650) long, 277 (225–377) wide. Tergites: present as 2 small submedial plates on segment I; absent on segments II to VII; represented by a transverse band on segment VIII. Sternites absent except for a weakly sclerotized area on either side of segment VIII. Ostioles greatly reduced. Abdominal setae: dorsal setae on each side in transverse rows on each segment and longitudinally as a medial and submedial band; medial setae as follows: segment VIII always with 2 setae on posterior edge of tergites; segment VII, 2–3 setae; segment VI, 3–4 setae; segments I to V, 2 setae; and submedial setae: in double row on segments I to VII, absent segment VIII. Segment II occasionally with a single seta between medial and submedial setae. Pleural setae in transverse rows on each side: segments I and II, 2–3 setae; segments II to VII 4–6 setae. Ventral setae on each side in transverse rows and longitudinally in medial and submedial bands; medial setae arranged as follows: segments II to VII, 2 setae; submedial setae as follows; segments II to VII, 1 seta. Segment III usually with a single seta between medial and submedial setae. Abdominal pores: pleural pores: 0–3 minute circular pores (Fig. 6F), on segments I to VII; ventral pores: 0–1 disc pores near submedial setae; 0–1 circular pores on segments III to VIII near medial, and occasionally, submedial setae.

Glandular pouch well developed, with a pair of long tail setae and 2 long hair-like setae.

Genital segment: small, triangular dorsally; style curved upwards in lateral view. Penial sheath 112 (90–125) long, 80 (76–88) wide. Basal ridge well developed, its projection and process of penial sheath distinct. Aedeagus tapering posteriorly to a point. Setae of genital segment on each side: dorsally, 3 near style; ven-

Table 2. Length and width of leg segments of adult male *Melanococcus albizziae.*

	Segment (μm)				
	Coxa	Trochanter	Femur	Tibia	Tarsus
Leg I					
Length					
range	30–62	50–62	137–172	155–205	75–87
mean	46	58	152	167	83
n	10	11	8	12	12
Width					
range	47–62	25–37	32–40	17–25	15–20
mean	55	29	36	21	19
n	10	11	8	12	12
Leg II					
Length					
range	37–50	25–57	125–155	147–200	75–100
mean	44	55	147	186	84
n	8	8	10	12	14
Width					
range	45–55	22–27	32–40	17–22	15–20
mean	49	26	35	18	19
n	8	8	10	12	14
Leg III					
Length					
range	37–62	55–62	137–187	175–250	75–100
mean	49	60	150	217	87
n	10	9	12	14	14
Width					
range	47–55	25–30	32–42	17–22	15–22
mean	52	25	36	19	17
n	10	9	12	14	14

trally 3–4 setae on the penial sheath: 2–3 setal sensilla on process.

Remarks. This species was simultaneously described under two different names in the same paper (Maskell, 1892), highlighting the historical difficulties modern workers have faced with the Australian mealybugs. Although Fernald (1902) transferred the species to *Pseudococcus* Westwood, Froggatt (1916) later returned it to *Dactylopius* O. Costa. The genus *Dactylopius* is now the sole member of the Dactylopiidae (De Lotto, 1974), the family being characterized by its host specificity to the cactaceous plants, particularly those of the genus *Opuntia. Dactylopius albizziae* is thereby excluded from this genus and a new genus, *Melanococcus,* was erected to accomodate it (Williams, 1985).

M. albizziae can be distinguished from other members of the genus by the conical dorsal setae being about the same size as those on the anal lobe (Williams, 1985).

Key to instars of *Melanococcus albizziae* (Maskell)

Although it was possible to seperate instars on the length of the hind femur, other morphological characters were also diagnostic. These characters have been used to construct the key presented here. Although not described here the adult female has been included for completeness. As the adult male is easily distinguished from other instars, it has not been included.

1. Wing buds present 5
— Wing buds absent 2

2. Derm without tubular ducts and multiocular pores; each dorsal cerarius with only 2 setae ..... 1st instar
— Derm without either tubular ducts or multiocular pores; dorsal cerarii with 3 setae 3
3. At least marginal cerarii of abdominal segment VIII with more than 2 setae; multilocular pores on abdomen in region of vulva Adult female
— Marginal cerarii with a maximum of 2 setae; multilocular pores either absent or if present, on thorax only 4
4. Multilocular pores absent; minute circular pores on dorsum; anal lobe with 3–4 trilocular pores, several oral collar ducts and 4–6 auxilary setae ..... 3rd instar female
— Multilocular pores present, but restricted to area anteromedial to hind coxa; minute circular pores absent; anal lobe with 1 auxilary seta and 1 trilocular pore ..... 2nd instar female
5. Wing pads as long as wide; antennal segments partly fused, segmentation variable; legs without tibiotarsal articulation ..... 3rd instar male
— Wing pads longer than wide; antennae with 9 well defined segments; legs with tibiotarsal articulation ..... 4th instar male

Discussion

The presence of marginal cerarii is a characteristic of the Pseudococcidae, but dorsal or medial cerarii are less common (Ferris, 1950; McKenzie, 1967). The presence of dorsal cerarii on *M. albizziae* is thus noteworthy. These structures are characterised in first instars by two conical setae and a pair of associated pores (Fig. 1C), and in subsequent instars by three setae and associated pores (Fig. 2C, 3C). The setae of each dorsal cerarius are equal or subequal in size and shape to the setae of the corresponding marginal cerarius. The dorsal cerarii are located medially on each abdominal segment and like the marginal cerarii, are most distinct on abdominal segment VII, but become less obvious anteriorly. The actual number of distinguishable cerarii, both marginal and dorsal, varied from instar to instar and individual to individual, with the largest recognizable number being found on the first instar and the smallest number on the adult female. On all individuals examined, no dorsal cerarii were found anterior to the abdomen. In male instars the abdominal segments also bore dorsal setae arranged into groups of three along the midline. However unlike the females, there were no pores associated with these setae (Fig. 4C, 5C, 6A). Pre-adult male instars also had marginal cerarii, but these were associated with tubular ducts rather than trilocular pores as in female instars. It is of interest to note that while it is often difficult to differentiate types of tubular ducts in female instars of Australian mealybugs (Williams, 1985), no such difficulties were observed in the males of *M. albizziae*.

The trilocular pores of the dorsal cerarii of the first instar exhibited an interesting orientation in relationship to the setae. In all material examined the cerarii of abdominal segments IV to VII had a pair of setae between a pair of pores (Fig. 1C), while the cerarii of segments I to III had the pair of pores between the pair of setae (Fig. 1D). It is not known why this change in orientation occurred, but it was a constant pattern in all individuals.

The classification of the Pseudococcidae, as with all other families of Coccoidea, is still firmly based on female morphology (Williams, 1985), although other instars, including the adult males, provide characters of phylogenetic value (Afifi, 1968; Boratynski, 1970; Williams, 1985). Specifically males are thought to better represent ancestral affinities, particularly at higher levels of classification (Boratynski, 1970), although they can also be useful at an intrafamiial level (Boratynski and Davies, 1971; Davies and Boratynski, 1979; Davies, 1981). Although descriptions of adult males are not available for the two genera indicated by female morphology to be most closely related to *Melanococcus*, it was possible to compare the adult male of *M. albizziae* with the twenty species of mealybugs described by Afifi (1968).

Based on these data sets Afifi (1968) used 134 characters to separate the species into four groups of genera. Using the same character states, *M. albizziae* shows greatest affinity (85–101 shared character states) with the *Planococcus*-group. Within the *Planococcus*-group most features were shared with two *Nipaecoccus* Sulc

species, *N. vastor* (Maskell) (101) and *N. nipae* (98). However *M. albizziae* also exhibited character states considered exclusive to other groups of genera. These are: (i) the lack of a ventral preocular depression (*Saccharicoccus*-group), (ii) a ridge-like ventral margin to the proepisternum (Ceroputo group), and (iii) the absence of a trochantin (*Nairobia*-group). While the first and last of these features can be explained by convergence, the ridge-like ventral margin to the proepisternum, thought by Afifi (1968) to be a specialization, can not. The *Planococcus*-group exhibited the generalized condition of most character states and as a whole was considered by Afifi (1968) to be the most ancestral of the four groups. It would seem that based on male morphology *M. albizziae* is closely allied to the *Planococcus*-group and *Nipaecoccus* in particular. However within the limitations of Afifi's analysis, the presence of the ridge-like ventral margin to the proepisternum in *M. albizziae* alone is sufficient to exclude the species from the grouping.

Female scale insects are neotenic, highly specialized plant parasites that display a high degree of convergence and so provide few characters on which to base evolutionary relationships. The morphologically more conservative males retain primitive characters lost in the female and provide potential clues to relationships. However the Australian phytophagous fauna has been characterised by rapid evolution and specialization paralleling the rapid evolution of the autochthonous element of the Australian flora (Barlow, 1981; New, 1983). This provides an ideal situation for diffuse coevolution (Fox, 1981) and it has been postulated that this leads to the evolution of taxonomically difficult groups (New, 1983). Australian mealybugs are thought to be of Gondwanan origin (Williams, 1985), with most species found on host-plant genera with (evolutionary) recent and extensive radiations (Gill, 1975; Williams, 1985). Is not surprising, then, that *M. albizziae* failed to fit into the Afifi's (1968) framework, given that it was based on cosmopolitan and non-Australian species.

It is possible that the study of the taxonomy of male scale insects may play an important role in illuminating the systematic of the Pseudococcidae and other families of the Australian fauna. For example Williams (1985) has suggested that the true relationships of the Australian species of *Pseudococcus* may only be understood when the males are studied.

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Appendix

Abbreviations used in figures.

ab, antennal bristles. ads, abdominal dorsal setae. aed, aedeagus. al, alar lobe. als, alar setae. amsp, anterior metasternal pores. amss, anterior metasternal setae. anp, anterior notal wing process. apar, anterior postalar ridge. app, abdominal pleural pores. aps, abdominal pleural setae. as, abdominal sternite. asdp, antespiracular dorsal pores. at, abdominal tergites. avp, abdominal ventral pores. avs, abdominal ventral setae. bas, basalare. bra, basal rod of aedeagus. brps, basal ridge of penial sheath. ca, cranial apophysis. cl, claw. cx, coxa. dhp, dorsal head pores. dhs, dorsal head setae. dmcr, dorsal arm of midcranial ridge. dse, dorsal simple eyes. epm2, mesepimeron. epm3, metepimeron. eps2, mesepisternum. eps3, metepisternum. f, furca. FIII-X, flagellum segments – 3rd to 10th. fm, femur. fs, fleshy setae. g, gena. gls, setae of glandular pouch. gp, glandular pouch. gs, genal setae. gts, setae of genital segment. h, hamulohaltere. lmcr, lateral arm of midcranial ridge. lpp, lateral pronotal pores. med, marginal ridge. mpnp, medial pronotal pores. mpns, medial pronotal setae. mps, metapleural setae. mr, marginal ridge. mts, metatergal setae. o, ocellus. ocs, ocular sclerite. ost, ostiole. pa, postalare. pcr2, precoxal ridge of mesothorax. pcr3, precoxal ridge of metathorax. pdc, pedicel. pepcv, proepisternum + cervical sclerite. plr2, mesopleural ridge. plr3, metapleural ridge. pmp, postmesostigmatal pores. pms, postmesostigmatal setae. pn3, metapostnotum. pna, postnotal apophysis. pn3r, metpostnotal ridge. pocr, postocular ridge. por, postocular ridge. ppar, posterior postalar ridge. pra, prealare. prar, prealar ridge. prn, lateral pronotal sclerite. prnr, pronotal ridge. pro, process of penial sheath. procr, preocular ridge. pror, preoral ridge. pros, setal sensilla of process of penial sheath. prsc, prescutum. pscr, prescutal ridge. pscse, prescutal setae. pt, post tergite. pwp, mesopleural wing process. rad, radius. scl, scutellum. scp, scape. sct, scutum. sctse, scutal setae. sens, circular sensoria. ser, subepisternal ridge. set scla, subapical sensory setae. sp2, mesothoracic spiracle. sp3, metathoracic spiracle. sp2p, mesospiracular pores. sp3p, metaspiracular pores. st, style. stn1, prosternum. stn2, mesosternum (basisternum). stn1r, prosternal ridge. stn1s, prosternal setae. stn2s, basisternal setae. tar, tarsus. tdgt, tarsal digitules. vhs, ventral head setae. vmcr, ventral arm of midcranial ridge. vse, ventral simple eyes.

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REDESCRIPTION OF *CRYPTES BACCATUS* (MASKELL) (COCCOIDEA: COCCIDAE), AN AUSTRALIAN SPECIES OF SOFT SCALE

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Abstract

Farrell, G.S., 1990. Redescription of *Cryptes baccatus* (Maskell) (Coccoidea: Coccidae), an Australian species of soft scale. *Memoirs of the Museum of Victoria* 51(1): 65–82.

All instars of the male and female of *Cryptes baccatus* (Maskell) are described and illustrated. Characteristic features of each instar are discussed. Morphology of the adult male is examined in detail and compared with that of other coccid species. The status of the genus is examined with regard to the morphology of the adult male and female.

Introduction

The Coccidae are difficult to classify and there are few keys to species. Little has been written on the family (Williams and Kosztarab, 1972) although a large number of species are economically important (De Lotto, 1965). For most species the few diagnostic characters used in the past are either unreliable or of minor taxonomic importance (De Lotto, 1965).

There has been little recent study on endemic soft scales in Australia. Froggatt's (1921) work, the most recent treatment, was not systematic and was little better then a catalogue. One endemic Australian genus of interest is *Cryptes* Cockerell and Parrott. This genus is monotypic and *Cryptes baccatus* (Maskell) is restricted to *Acacia* Willd. (Mimosaceae) Although distinctively a coccid, its relationship within the family is uncertain (Steinweden, 1929). No modern descriptions of the species exist and while work was being carried out on its ecology the opportunity was taken to describe all stages of both the male and female of this unusual species.

The scale occurs in large aggregations, the sexes either occurring together or in separate, but proximate aggregations. The species has been found along the east coast of Australia, although the northern limits of its distribution are unknown. To the south its range extends into South Australia and it has also been found in the Perth region of Western Australia (Farrell, 1985).

Materials and methods

Material was collected and prepared as described by Farrell (1990). The development of the adult female is characterised by an extended period of allometric growth, with the female becoming heavily sclerotized and convex towards the end of this period (Farrell, 1985). This renders mature females useless for distinguishing morphological characters. Descriptions of adult females presented here are restricted to young individuals prior to this stage. All measurements of morphological characters are in micrometers and are given as either ranges or means followed by ranges in parentheses. Unless stated otherwise a minimum of ten replicates were used for each character. Terminology for female instars is based on Ray and Williams (1980) and for male instars on Giliomee (1967) and Ray and Williams (1980). Illustrations (except for adult male) include a central drawing of the insect with the left half representing the dorsal aspect and the right half the ventral aspect. Enlargements of important details are placed around the perimeter of the figure. These enlargements are not to the same scale in each illustration, nor are the dermal structures and enlargements in direct proportion to each other. Scale lines are for the central drawing only, the exception to this being the illustration of the adult male. Details of the adult male illustration are provided in the figure legend. Voucher specimens of all stages have been lodged in the Australian National Insect Collection, Canberra.

Cryptes Cockerell and Parrot

Cryptes Cockerell and Parrott, 1899: 161. — 1901: 58. — Froggatt, 1921: 42. — Morrison and Morrison, 1922: 80. — Steinweden, 1929: 233.

Type species. Lecanium baccatum Maskell, 1891.

Remarks. This monotypic genus was erected by Cockerell and Parrott for a species of *Lecanium* Bouche described by Maskell (1891) from a specimen collected on *Acacia paradoxa* Br. Cockerell and Parrott (1899), upon examining material sent to them by J. Lidgett believed that the species was more closely related to *Kermes* Latreille than to *Lecanium*. However, as the species showed a mixture of features common to both genera they decided, based on the male test, that it warranted a distinct genus.

Morrison and Morrison (1922) showed that Cockerell and Parrott were the first to use *Cryptes* as a genus, despite some earlier confusion in the literature. Steinweden (1929) concluded that the following features diagnose the genus: the long, curved, blunt-tipped marginal setae and body setae; the stout, very short, blunt stigmatic setae of the first instar; and the completely fused anal cleft of the adult female. As the last feature is absent in young specimens of adult females, it is not entirely satisfactory as a diagnostic character. Fusion of the anal cleft occurs as a result of allometric growth of the scale dorsum and can take up to a month to be completed (Farrell, 1985). This character should be considered of secondary importance in defining the genus.

Cryptes baccatus (Maskell)

Lecanium baccatum Maskell, 1891: 20. — 1893: 217. — 1897: 311.

Lecanium baccatum var. *marmoreum* Fuller, 1899: 458.

Cryptes baccatus Cockerell and Parrott, 1899: 161. — Froggatt, 1921: 42. — Morrison and Morrison, 1922: 80.

Egg. Ellipsoidal, 253 (228 — 266) long, 118 (95–133) wide (n = 20). Covered with a light dusting of white wax, probably secreted by the ventral abdominal pores of the female during oviposition; orange when laid, but gradually become lighter in colour, yellowish shortly before hatching.

First instar (Fig. 1). General Appearance: Body flattened, elongate-ovoid, tan to mustard in colour. Slide-mounted specimens 749 (589–961) long, 433 (310–589) wide.

Dorsum: Derm membranous. Marginal setae (Fig. 1A), 26 (18–40) long, blunt ended, often bent posteriorly, distributed as follows: 13–19 between anterior spiracular furrows, 2–3 between anterior and posterior spiracular furrows of each side, 22–30 on remainder of body. Body setae (Fig. 1B), 34 (26–46) long, blunt ended and often bent posteriorly; 18–20 on derm arranged in 2 longitudinal rows. Two spiracular setae (Fig. 1C), in anterior spiracular furrow, 1 in posterior spiracular furrow; 8.0 (6.6–9.6) long, 3.7 (3.0–4.8) wide. Eyes on margin. No pores, tubular ducts or tubercles on derm.

Anal Plates: Each plate triangular with rounded angles; 75 (69–81) long, 22 (18–27) wide, cephalolateral margin 43 (39–53) long, caudolateral margin 42 (33–48) long. Each plate (Fig. 1D), with 3 apical setae, 1 discal seta, 1 subapical seta. Anal fold with 1 pair of fringe setae. Median apical setae (Fig. 1E), approximately half body length. Anal ring (Fig. 1F), with 6 hairs and no pores.

Venter: Segmentation faintly delineated on abdomen. Submarginal setae (Fig. 1G), in longitudinal row on each side of body arranged as follows: 7 setae on abdomen, 1 seta between spiracular furrows, 1 seta medially on head, between antennae. Body setae (Fig. 1H), shorter and stouter than submarginal setae, arranged on each side of abdomen in row of 6–7 setae parallel to submarginal setae. One pair of long setae anterior to anal cleft. One pair of interantennal setae. Antennae (Fig. 1I), well developed, 6 segmented, 138 (120–147) long. Legs well developed, without tibiotarsal sclerosis; 2 tarsal digitules, proximal 1 with knobbed apex, distal 1 with plate-like apex; 2 claw digitules with knobbed apex. Length of hind femur: 90 (84–91, n = 20). Spiracular furrows with quinquelocular pores (Fig. 1J); anterior band with 2 pores, posterior band with 3 pores. No other pores on venter. Tubular ducts and microducts absent.

Second instar (*Female*) (Fig. 2). Body elliptical to slightly pyriform, with white seta-like wax fringe. Yellow-white in colour. Slide-mounted specimens 1166 (1054–1314) long, 783 (651–930) wide.

Dorsum: Derm membranous. Marginal setae (Fig. 2A), 17.6 (14.4–28.2) long, blunt ended, distributed as follows: 17 (14–19) between anterior spiracular furrows, 3 (3–4) between anterior and posterior spiracular furrows of each side, 30 (27–32) on remainder of body. Two spiracular setae (Fig. 2B), in anterior spiracular furrow, 1 in posterior spiracular furrow; 7.0 (4.8–9.0) long, 7.0 (5.4–9.0) wide. Body setae, tubular ducts, tubercles, eyes and pores absent on derm.

Anal Plates: Each plate triangular, but with rounded angles and median edge concave; 105 (100–114) long, 38 (35–45) wide, cephalolateral

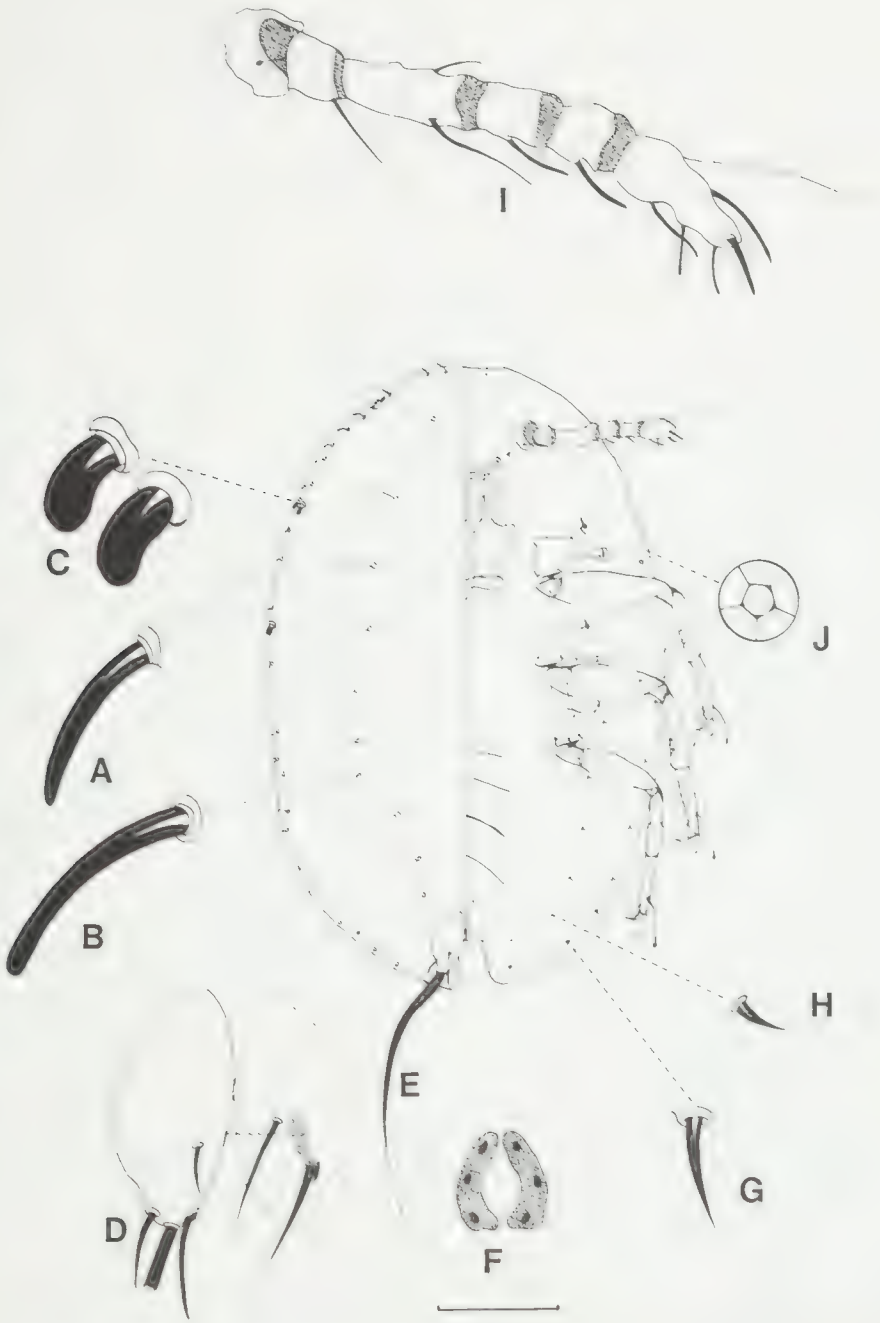

Figure 1. First instar *Cryptes baccatus*. (See Appendix for abbreviations in this and other figures. All scale lines 150 μm long).

margin 66 (60–72) long, caudolateral margin 63 (55–69) long. Each plate (Fig. 2C), with 2 apical setae, 1 discal seta, 1 subdiscal, 3 subapical seta. Anal fold with 1 pair of fringe setae (Fig. 2C). Anal ring (Fig. 2D), with 8 hairs and no pores.

Venter: Segmentation delineated on thorax and abdomen by membranous folds. Submarginal setae (Fig. 2E), long, pointed, 12.8 (8.4–18.0) long, arranged on each side of the body as follows: on abdomen in either 1 or 2 rows of 4 to

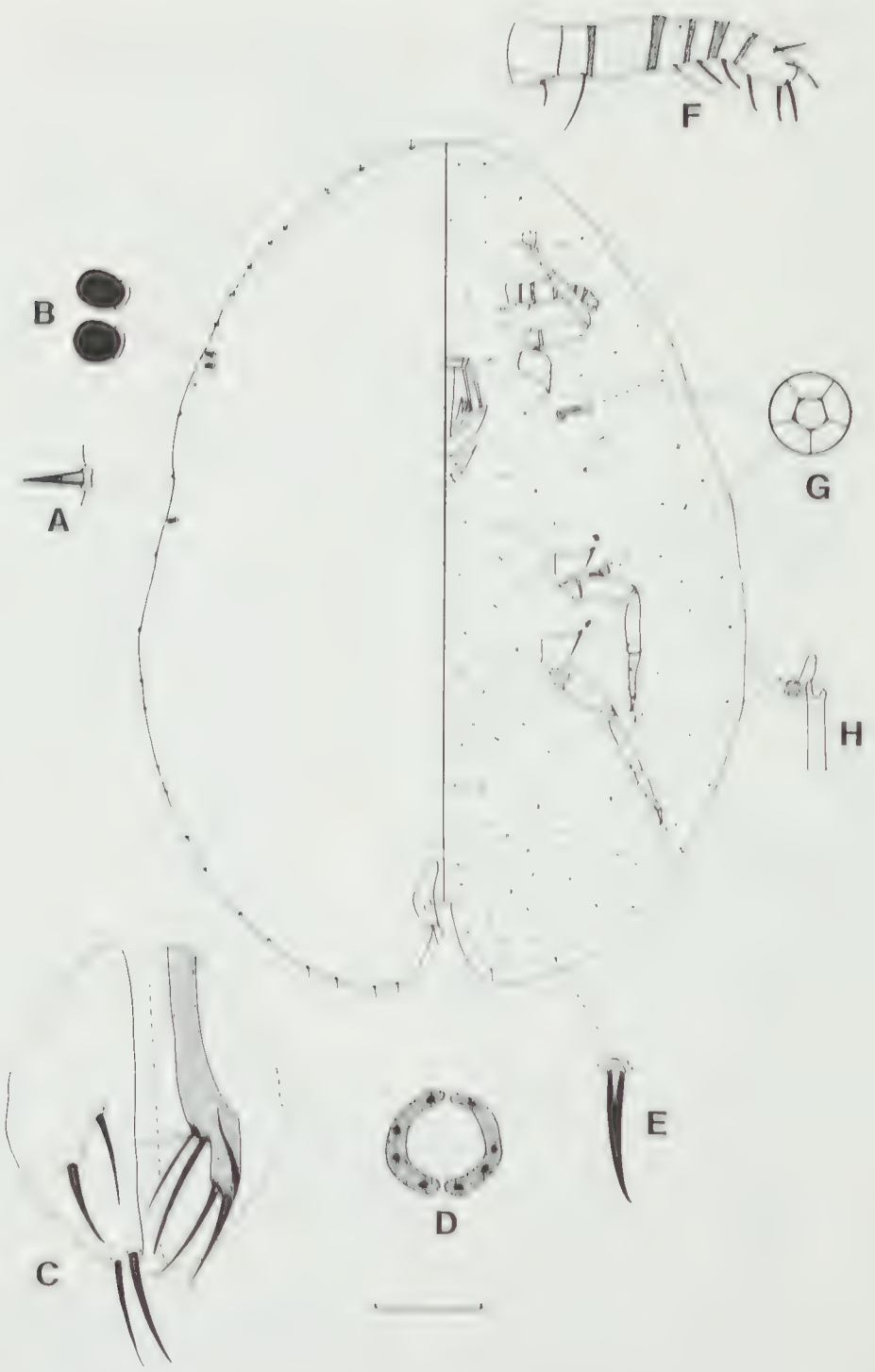

Figure 2. Second instar female *Cryptes baccatus*.

7 setae, posterior setae of outer row longest, 1–3 setae between spiracular furrows, 6–8 setae on whole head, between antennae. Body setae shorter and stouter than submarginal setae. Two pairs of long setae on abdominal segments VI and VII. Antennae (Fig. 2F), not well developed, 7 segmented, 118 (111–132) long. Two pairs of setae near antennal scape, 1 approximately twice

the length of other. Legs well developed, without tibiotarsal sclerosis, claw and tarsal digitules slender, knobbed. Length of hind femur 90 (81–102, n = 19). Spiracular pores quinquelocular (Fig. 2G), pore bands of variable width; anterior band with 6–10 pores, posterior band with 6–12 pores. Tubular ducts (Fig. 2H), scattered over venter. Microspines on abdomen, concentrated in anal cleft. Microducts absent.

Second instar (*Male*) (Fig. 3). Body elongate-oval, may be enclosed in a cottony wax test with a glassy operculum posteriorly. In life, tan in colour, test white. Slide-mounted specimens 1453 (1110–1860) long, 904 (775–1042) wide.

Dorsum: Derm initially membranous but becoming progressively sclerotized in older specimens. Marginal setae (Fig. 3A), 16.1 (12.0–23.0) long, blunt ended, distributed as follows: 14 (12–16) between anterior spiracular furrows, 3 (2–3) between anterior and posterior spiracular furrows of each side, 24 (16–29) on remainder of body. Two spiracular setae (Fig. 2B), in anterior spiracular furrow (occasionally 3), 1 in posterior spiracular furrow; 7.0 (4.8–9.0) long, 7.0 (5.4–9.0) wide. Tubular ducts (Fig. 3C1) scattered over derm, but absent from area corresponding to operculum of test. Sclerotization of area surrounding duct opening (Fig. 3C2) resulting in semicircular band corresponding to anterodorsal margin of operculum. Body setae, tubercles, eyes and pores absent on derm.

Anal Plates: Each plate triangular, but with rounded angles and median edge concave; 89 (78–96) long, 36 (27–51) wide, cephalolateral margin 58 (48–69) long, caudolateral margin 56 (48–62) long. Each plate (Fig. 3D), with 2 apical setae, 1 discal seta, 1 subdiscal, 3 subapical seta. Anal fold with 1 pair of fringe setae (Fig. 3D). Anal ring (Fig. 3E), with 8 hairs and no pores.

Venter: Segmentation on thorax and abdomen delineated by sclerotization medially. Submarginal setae (Fig. 3F), long, pointed, 12.8 (8.4–18.0) long, arranged on each side of the body as follows: on abdomen in either 1 or 2 rows of 4 to 7 setae, posterior setae of outer row longest, 1–2 setae between spiracular furrows, normally a pair of setae medially on head, between antennae, although 3 setae have been observed. Body setae (Fig. 3G) shorter and stouter than submarginal setae, scattered over body. Two pairs of long setae on abdominal segments VI and VII. Antennae (Fig. 3H), not well developed, 7 segmented, 105 (96–114) long. Two pairs of setae associated with each antennal scape, 1 approximately twice the length of other. Legs well developed, without tibiotarsal sclerosis, claw and tarsal digitules slender, knobbed. Length of hind femur: 79 (69–87, n = 19). Spiracular pores quinquelocular (Fig. 3I), pore bands of variable width; anterior band with 6–10 pores, posterior band with 6–12 pores. Tubular ducts (Fig. 3J), scattered over venter, more concentrated posteriorly. A submarginal row of tubular ducts also found. Microspines on abdomen, concentrated in anal cleft. Microducts absent.

Third instar (*Female*) (Fig. 4). Body subelliptical to pyriform, brown to tan in colour. Size of slide-mounted material 1277 (1178–1426) long, 1011 (930–1054) wide.

Dorsum: Derm membranous. Marginal setae (Fig. 4A), 18 (12–24) long, blunt ended, distributed as follows: 22–33 between anterior spiracular furrows, 5–7 between anterior and posterior spiracular furrows of each side, 44–58 on remainder of body. Body setae (Fig. 4B), as long or longer than marginal setae, spread in a semicircular ring anterior to anal plates, irregularly over rest of derm. Two spiracular setae (Fig. 4C), in anterior spiracular furrow (occasionally 3), 1 in posterior spiracular furrow; 8.0 (6.6–9.0) long, 8.0 (6.6–9.0) wide. Submarginal tubercles absent. Simple pores (Fig. 4D), restricted to semicircular ring anterior to anal plates.

Anal Plates: Each plate triangular, but with rounded angles and median edge concave; 118 (96–141) long, 45 (30–48) wide, cephalolateral margin 70 (54-87) long, caudolateral margin 74 (51–90) long. Each plate (Fig. 4E), with 2 apical setae, 1 discal seta, 1 subdiscal, 3 subapical seta. Anal fold with 1 pair of fringe setae (Fig. 4E). Anal ring (Fig. 4F), with 8 hairs and no pores.

Venter: Segmentation delineated on thorax and abdomen by membranous folds. Submarginal setae (Fig. 4G), long, pointed, arranged as follows: 16–23 around head, between anterior spiracular furrows, 3–6 setae between spiracular furrows, 48–50 setae on thorax and abdomen between posterior spiracular furrows. Body setae (Fig. 4H), shorter than submarginal setae and more bristle-like, scattered over venter. One pair of long setae medially on abdominal segment VII, flanked proximally by 2 pairs of shorter setae. Antennae not well developed, 7 segmented, 1332 (1080–1650) long. Legs well developed, without tibiotarsal sclerosis, claw and tarsal digitules slender, knobbed. Length of hind femur: 116 (109–153, n = 9). Spiracular pores quinquelocular (Fig.4I), pore bands of variable width; anterior band with 22–26 pores,

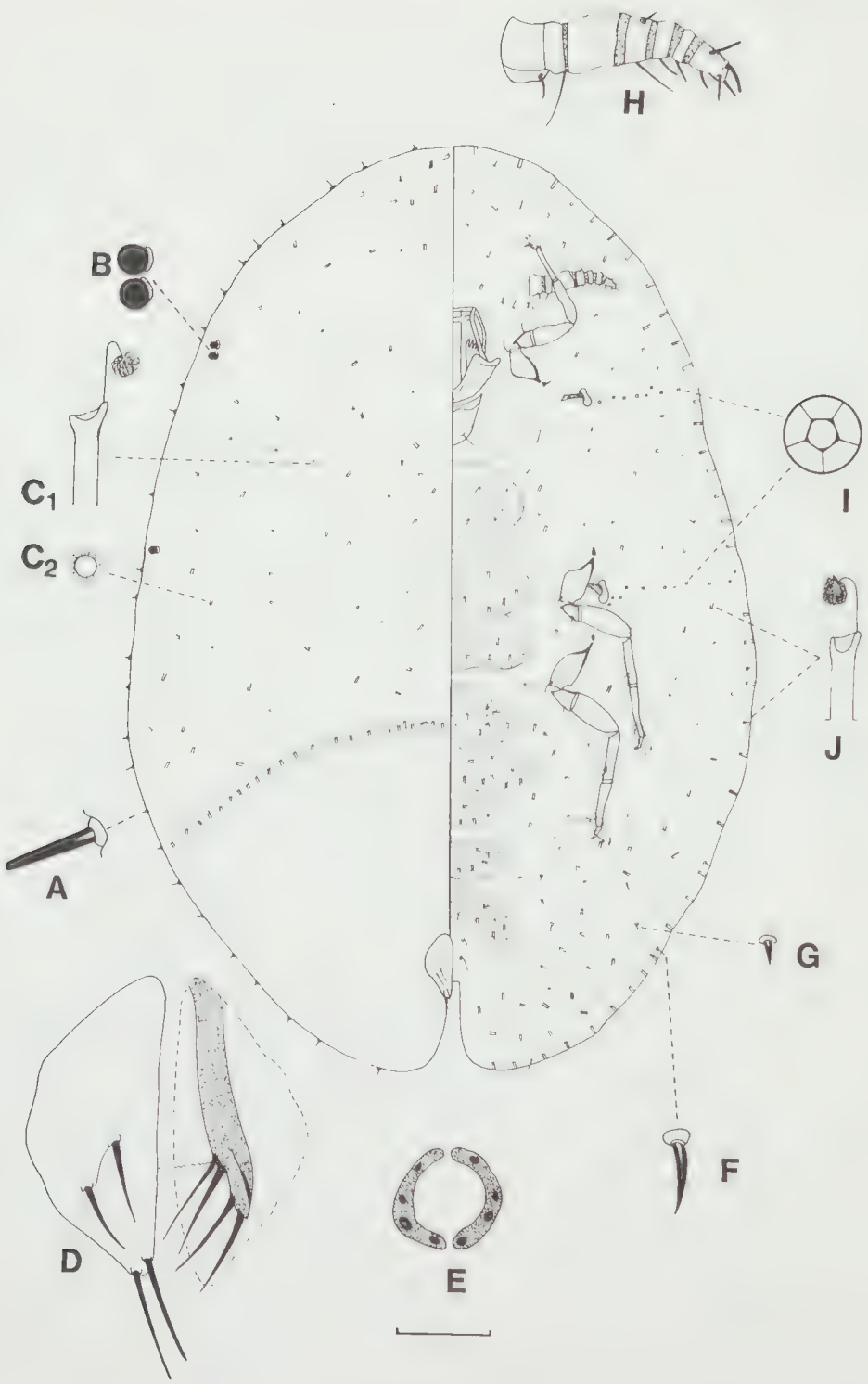

Figure 3. Second instar male *Cryptes baccatus*.

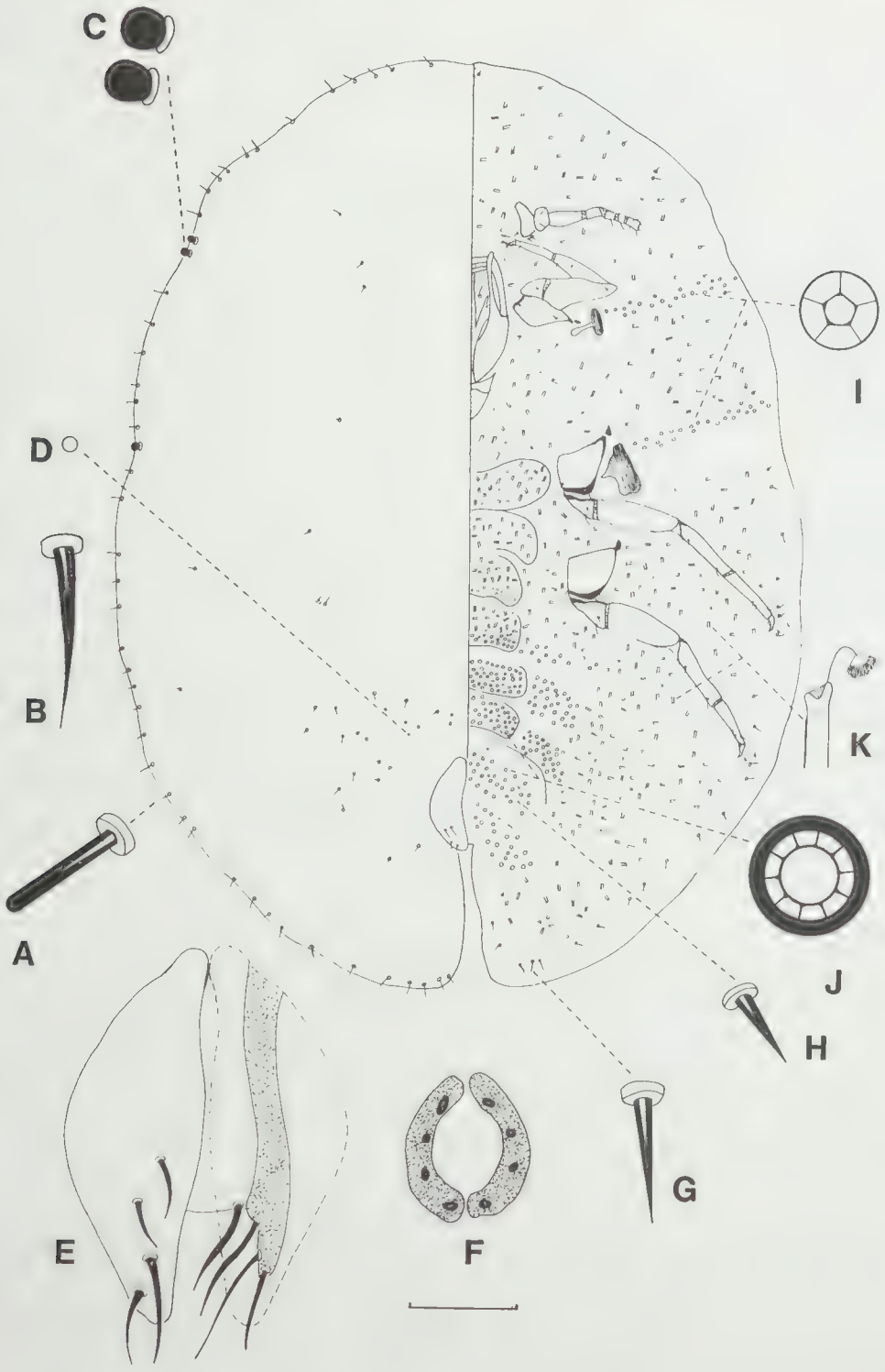

Figure 4. Third instar female *Cryptes baccatus*.

posterior band with 22–38 pores. Multilocular pores (Fig. 4J), restricted to medial area of abdominal segments. Tubular ducts (Fig. 4K), scattered over venter.

Third instar (*Male*) (Fig. 5). Enclosed within white cottony wax test with glassy operculum. Body elliptical. Slide-mounted specimens 1760 (1628–1910) long, 970 (862–1102) wide.

Dorsum and Pleural Surface: Derm membranous. Pair of short peg-like setae (Fig. 5A), on head. No setae on thorax. A pair of peg-like setae (Fig. 5B) on each of abdominal segments II to VII. Long and bristle-like dorsopleural setae (Fig. 5C) in groups of 1–3 on segments IV to VII. Shorter ventropleural setae (Fig. 5D) on abdominal segments IV to VII. Eyes present on margin above level of antennal scape. No spiracular setae, submarginal tubercles, pores or ducts present. Wing buds 516 (475–550) long, 200 (173–238) wide.

Anal Plates: Plates reduced to an irregular bilobed membranous ring. Anal ring absent. Penial sheath lightly sclerotized, no setae: genital opening subapical. Sheath 107 (90–135) long, 114 (90–150) wide.

Venter: Pairs of peg-like setae between antennal bases. Occasionally 1 or 2 longer bristle-like setae (Fig. 5E), at base of each hind coxa. Ventral abdominal setae: a pair on each of abdominal segments II to VI (Fig. 5F); 3 pairs on segment VII. Antennae mainly membranous, 9 segmented, 341 (315–405) long. Legs mainly membranous, with poorly defined segmentation. Ducts and spiracular pores absent.

Fourth instar (*Adult Female*) (Fig. 6). Living scale varying in colour from brown in newly moulted, pre-settled females to grey in pre-oviposition females. Post-oviposition females dark brown. Shape varing from pyriform in newly moulted females to sub-spherical in reproductive females. Distortion of shape due to aggregation may result in a "corn on the cob" effect. Description based on pre-reproductive females. Size of slide-mounted material: immature, pre-settled individuals; 1795 (1430–2140) long, 1443 (1200–1710) wide, post-oviposition individuals: 6047 (4200–7150) long, 5572 (4620–6290) wide.

Dorsum: Derm membranous in pre-oviposition females, completely sclerotized in post-oviposition females. Marginal setae (Fig. 6A), 34 (28–54) long, blunt ended, sometimes bent posteriorly, distributed as follows: 16–20 between anterior spiracular furrows, 3–6 between anterior and posterior spiracular furrows of each side, 25–30 on remainder of body. Body setae (Fig. 6B), as long as marginal setae but more slender, pointed apically, distributed over derm. Spiracular setae (Fig. 6C) sub-spherical in shape, 19 (15–20) long, 17 (15–20) wide. Two spiracular setae (occasionally 3), in anterior spiracular furrow, 1 in posterior spiracular furrow. Submarginal tubercles and tubular ducts absent. Simple pores (Fig. 6D), restricted to semicircular ring anterior to anal plates.

Anal Plates: Each plate triangular, but with rounded angles and median edge concave; 167 (141–180) long, 66 (54–99) wide, cephalolateral margin 106 (93–120) long, caudolateral margin 100 (96–108) long. Each plate (Fig. 6E), with 2 apical setae, 1 discal seta, 1 subdiscal, 2 subapical seta. Anal fold with 2 pairs of fringe setae (Fig. 6E). Anal ring (Fig. 6F), with 16 setae and no pores. Anal cleft open initially, progressively fused as scale grows, with anal plates becoming convex and area around plates becoming heavily sclerotized.

Venter: Segmentation, when delineated, on abdomen medially. Submarginal setae (Fig. 6G), long, pointed, scattered along margin, more numerous posteriorly. Body setae (Fig. 6H), shorter than submarginal setae and more bristle-like, scattered irregularly over venter. Three setae near each antenna. Pair of longer setae with nearby body setae on abdominal segment VII. Pair occasionally on abdominal segment VI. Antennae (Fig. 6I) well developed, 230 (200–250) long, usually 8 segmented, occasionally with incomplete fourth segment (Fig. 6J). Legs well developed, with tibia and tarsus fused, claw and tarsal digitules slender, knobbed. Length of hind femur: 155 (134–168, n = 22). Spiracular pores quinquelocular (Fig. 6K), pore bands of 1–3 pores wide; anterior band with 22–34 pores, posterior band with 30–44 pores. Multilocular pores (Fig. 6L), on abdomen medially, body setae scattered amongst pores. Tubular ducts (Fig. 6M), scattered over venter. Microspines in anal cleft. Small indistinguishable structures, possibly microducts scattered on head around mouthparts and between antennae.

Fourth instar (*Male*) (Fig. 7). Enclosed within white cottony wax test with glassy operculum. Body elliptical. Slide-mounted specimens 1746 (1580–1868) long, 788 (671–958) wide.

Dorsum and Pleural Surface: Derm membranous. Head and thorax without setae. A pair of short peg-like setae (Fig. 7A), on each of abdominal segments III to VII. Longer dorsopleural abdominal setae (Fig. 7B), in groups of

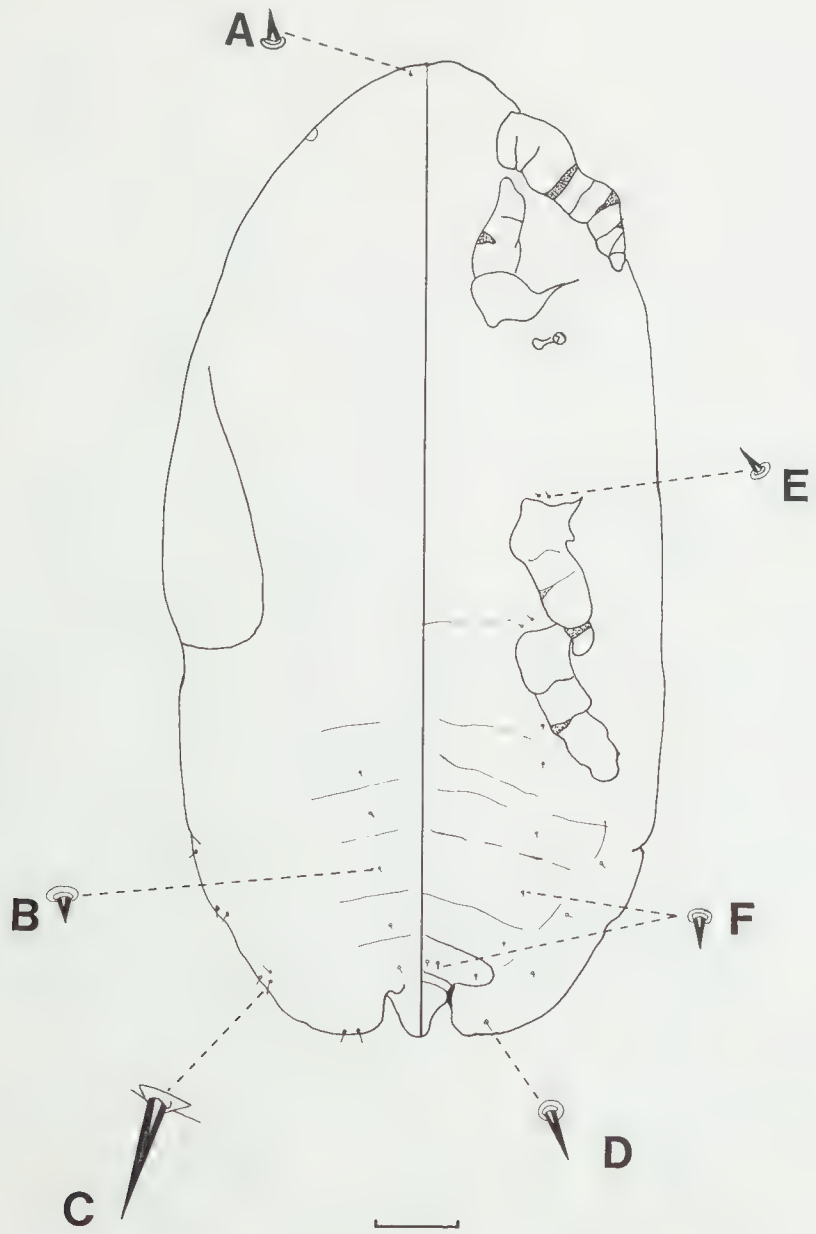

Figure 5. Third instar male *Cryptes baccatus*.

1–3 on segments IV to VII, usually becoming more numerous posteriorly. Shorter peg-like ventropleural setae (Fig. 7C), on segments V to VII. Eyes submarginal, posterior to scape. No spiracular setae, submarginal tubercles, pores or ducts present. Wing buds 749 (630–800) long, 254 (225–300) wide.

Anal Plates: Replaced by a membranous collar. Anal ring absent. A sclerotized penial sheath originates from membranous collar. Genital opening subapical.

Venter: No setae on head and thorax. Ventral abdominal setae (Fig. 7D), in pairs on each of abdominal segments II to VI, 3 pairs medially on

Figure 6. Fourth instar female (adult) *Cryptes baccatus*.

segment VII. Antennae elongate, largely membranous, 9–10 segmented, 717 (630–765) long. Legs mainly membranous, segmentation poorly defined, but apparent. Length of hind femur: 245 (216–276, n = 19). Ducts and spiracular pores absent.

Fifth instar (*Adult Male*) (Fig. 8). Living specimens red-brown with sclerotized areas dark brown-black, appendages yellowish-orange, wing with purplish tinge along radial vein; body robust; legs, antennae setose; abdomen with long wax filaments. Slide-mounted specimens, 2086 (1929–2367) long, 267 (237–312) wide; wing span 3263 (2989–3512).

Head: Typical coccid subconical shape in dorsal view (Fig. 8A); in lateral view (Fig. 8B), dorsoventrally elongated, anterodorsal bulge not pronounced. Length 304 (250–350), width 288 (275–300). Median crest sclerotized and weakly striated dorsally, but only weakly sclerotized anterodorsally to lateral arm of mid-cranial ridge (Fig. 8C); with 0–4 hair-like setae arranged in 2 groups of 0–2 setae, 1 group at level of, and other group anterior to, dorsal simple eyes. Dorsally mideranial ridge absent: posterior polygonal reticulation absent. Genae: moderate size, entirely membranous, without setae. Eyes: 2 pairs, subequal, corneae of dorsal eyes 50.8 (47.5–55.0) in diameter, corneae of ventral eyes 50.3 (45.0–57.5) in diameter. Ocellus small. Sclerotization of ocular sclerite apparent, although weakly in places; polygonal reticulation usually absent, if present weak and locally restricted; striation common, particularly between eyes. Preocular ridge moderately long with ventral part not extended far beyond articular process. Postocular ridge weak dorsally, definition increased lateroventrally but only well defined posteromedially; no apparent splitting to enclose ocellus. Dorsal ocular sclerite absent. Ventral head setae: restricted to 1 seta anterior to ocular sclerite, between articular process and mideranial ridge. Preoral ridge present. Tendon-like apodeme variable, usually absent. Cranial apophysis with apex truncated, extending to a level medial to ventral eyes. Anterior tentorial pits absent.

Antennae: Ten-segmented, filiform, 1173 (1047–1335) long. Ratio to: half body length 1:1.07–1.31 (average 1.14); posterior leg 1:0.87–1.34 (average 1.05); penial sheath 1:2.52–3.82 (average 3.14). Size of segments given in Table 1. All segments without polygonal reticulation, but striated. Scape with ventral sclerotization reduced; with hair-like setae only. Pedicel with

Table 1. Length and width of antennal segments of adult male *Cryptes baccatus*.

	Segment (μm)									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Length										
range	56.9–68.2	64.4–72.0	83.4–117.5	136.4–181.9	121.3–181.9	155.4–227.4	128.9–174.3	94.8–136.4	72.0–94.8	68.2–87.2
mean	64.2	68.0	98.1	154.3	163.8	182.1	151.4	114.3	87.8	77.3
n	14	14	18	18	18	18	18	18	18	18
Width										
range	56.9–68.2	53.1–72.0	37.9–49.3	34.1–41.7	30.3–37.9	30.3–41.7	30.3–37.9	30.3–37.9	30.3–37.9	30.3–37.9
mean	63.2	60.6	42.9	35.8	35.0	34.3	34.3	34.5	33.7	32.8
n	14	14	18	18	18	18	18	18	18	18

dorsal sensillum. Segments II to IX predominantly with fleshy setae, but occasionally 1 hair-like seta and basiconica sensillum per segment Apical segment (Fig. 8D), with 2 subapical setae; 0–3 antennal bristles.

Thorax

Prothorax: Pronotal ridge uninterrupted medially, although narrow. Lateral pronotal sclerite variable, but usually absent. Post-tergites absent. Proepisternum and cervical sclerite and pleural ridge as normally for family except for pleural apophysis, which is vestigial. Prosternum variable, transverse ridge strong, but often with semicircular plate extending posteriorly; sclerite triangular to subtriangular, size variable; median ridge, if present, extending anteriorly beyond apex of sclerite, but not reaching transverse ridge posteriorly. Setae absent from prothorax.

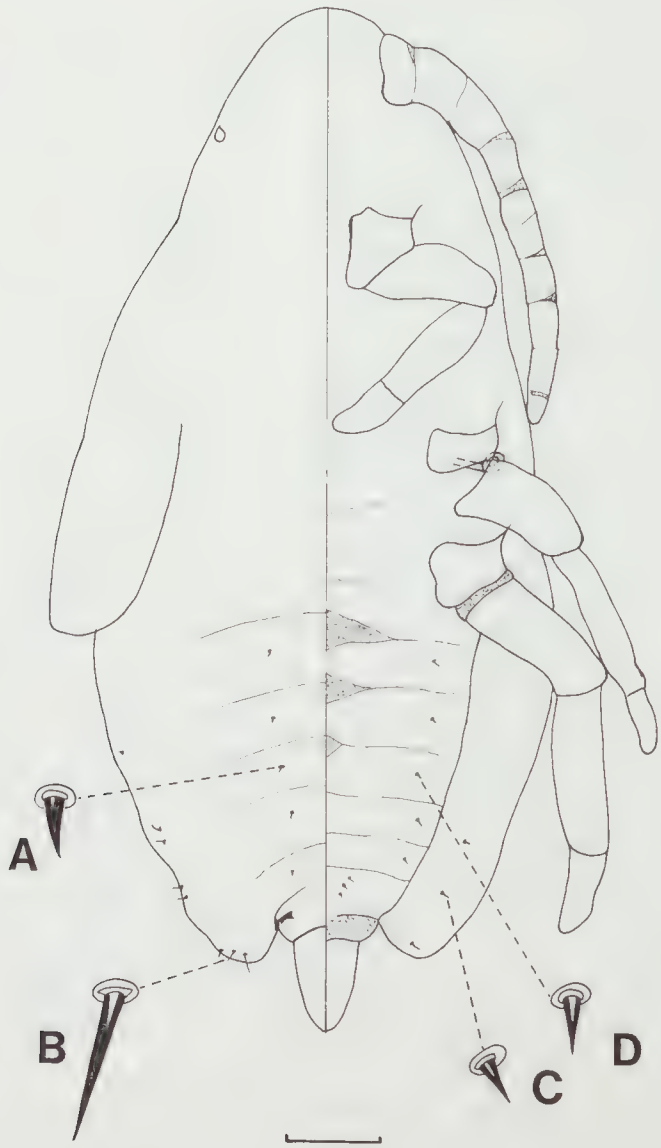

Figure 7. Fourth instar male *Cryptes baccatus.*

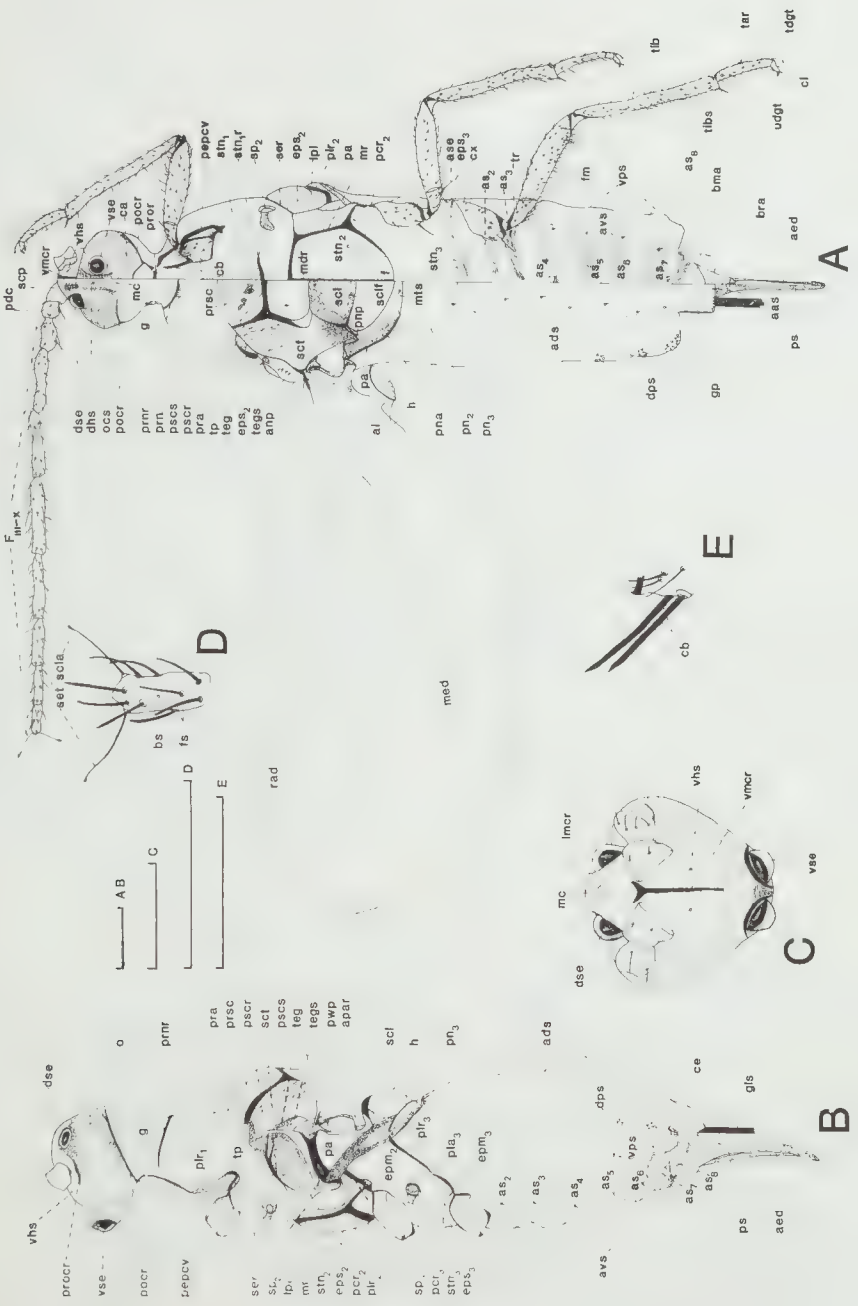

Figure 8. Fifth instar male (adult) *Cryptes baccatus*. A, dorsal and ventral aspect of body. B, lateral aspect of body. C, head, anterior view. D, 10th segment of antenna, dorsal view. E, distal edge of fore coxa, coxal bristle.

Mesothorax: Prescutum 129 (108–150) long, 260 (237–275) wide, curved anteriorly and bound laterally by prescutal ridge and posteriorly by prescutal suture; sclerotization even; polygonal reticulation variable, when present only faintly delineated; striations more normally present. Scutum: medium membranous area subrectangular 112 (90–127) long, 232 (217–250) wide, with 0–4 setae. Scutellum 136 (125–145) long 267 (237–312) wide, not tubular, without setae. Postnotum with anterior margin not overlapped by metathoracic fold; postnotal apophysis and postalare developed, the latter sclerotized such that it appears to bear a foramen lateromedially. Mesopleuron: mesopleural ridge strong, reaching coxal articulation; pleural apophysis well developed; pleural process developed, semicircular, not rounded. Basalare absent. Subalare small, difficult to detect. Episternum slightly striated, subepisternal ridge well developed, thicker medially; dorsal part of ridge split into two arms, ventrally ridge turns posteriorly, but stops well short of membranous cleft; sclerotized band joins episternum and lateral pleurite, closing membranous cleft anteriorly. Episternum small. Lateropleurite partly bound anteriorly by extension from marginal ridge. Basisternum 270 (250–312) long, 344 (330–395) wide, bounded by strong marginal ridge and precoxal ridges. Median ridge variable, when present may extend length of sclerite. Furca well developed. Setae absent. Mesothoracic spiracle with well developed peritreme; spiracular setae absent. Tegula small, 0–8 tegular setae. Axillary wing sclerites typical of family. Additional sclerites present.

Metathorax: Metanotum with posterior margin occasionally desclerotized medially, suspensorial sclerites small. Postnotum consisting of transverse sclerite on each side. Metatergal setae (1–3) usually present on each side of thorax. Pleural ridge well developed, may be interrupted anterior to episternum; with small wing process. Episternum extended ventrally, ridge not devel-

Table 2. Length and width of leg segments of adult male *Cryptes baccatus*.

	Segment (μm)				
	Coxa	Trochanter	Femur	Tibia	Tarsus
Leg I					
Length					
range	80–112	75–100	187–275	360–400	155–187
mean	97	87	247	374	176
n	12	13	12	13	13
Width					
range	75–105	42–55	50–75	27–37	22–32
mean	91	49	59	33	26
n	12	13	12	12	13
Leg II					
Length					
range	87–112	75–100	200–265	335–412	155–200
mean	96	86	231	374	167
n	14	14	15	15	16
Width					
range	80–100	45–62	50–75	25–37	22–32
mean	90	51	60	30	26
n	14	14	15	15	16
Leg III					
Length					
range	87–125	75–112	195–275	350–462	170–215
mean	108	97	252	422	195
n	14	21	21	21	21
Width					
range	100–137	47–75	62–90	32–50	25–37
mean	108	53	69	37	28
n	18	21	21	21	21

oped anteriorly; epimeron produced posteriorly. Metathoracic spiracle similar to mesothoracic one. Metasternal plate variable, sclerite often incomplete medially, irregularly shaped; metasternal setae absent.

Wings: Hyaline, 585 (538–625) long, 284 (237–325) wide, alar lobe and alar setae present. Hamulohalteres well developed, each with 1 apically hooked seta.

Legs: Moderately long, slender, hind pair longest, mid pair shortest; ratio hind leg to body length 1:1.53–2.03 (average 1.85). Length and width of segments given in Table 2. Each tibia with apical spur; each tarsus with 2 subequal digitules. Claws with 2 knobbed subequal digitules. Fore coxa with 2 large, distinctive coxal bristles (Fig. 8E). Mid and hind coxa with an elongate hair-like seta on proximal edge. Legs uniformly covered with fleshy setae.

Abdomen: Segments I–VII; tergites absent on all segments, sternites present on all segments; posterior sclerites present as transverse plates, anterior sclerites usually as 2 plates; sclerotization heaviest on posterior plates. Caudal extension of segment VII not sclerotized. Dorsal setae: hair-like only, segments I to VII with 1 seta on each side. Pleural setae represented by hair-like setae on segments V to VII only and associated with minute (1 simple) pores, arranged as follows: 2–3 dorsal pleural setae and 1 ventral pleural seta on segment V, 3-4 dorsal pleural setae and 1 ventral pleural seta on segment VI, 4 dorsal setae and 1 ventral pleural setae on segment VII, occasionally 1–2 dorsal pleural setae and 1 ventral pleural seta on segment IV. Ventral setae: hair-like only, arranged as follow: 1 seta each side of segments II to VII, segment VII also with 3–7 medial setae at posterior edge of sclerite.

Genital segment: Eighth segment expanded dorsally into subrectangular lobe overlaying base of penial sheath; containing glandular pouch. Penial sheath 380 long, 43 wide, lateral sclerotization not joined anteriorly to arms; basal rod short, sheath without setae, with small sensilla laterally over distal half.

Remarks. Maskell (1891) described the external features of the adult female and what appears to be the first instar, including details of the antennal segments. He also described the male test and figured the immature and adult female aggregation, details of adult females and male test, the first instar and antennae of the adult female and first instar. Fuller (1899) proposed a race for Western Australian specimens, *Lecanium baccatum* var. *marmoreum* Fuller, but its status is uncertain (Morrison and Morrison, 1922) although it is likely that, based on Fuller's description and illustrations, it should be synonymized with the nominal subspecies. Morrison and Morrison (1922) figured and described the first instar and adult females. Their illustration of the first instar nymph lacks the dorsal body setae found in this study and as there is no mention of them in the text, it must be assumed they were absent from the material examined (cf. Fig. 1 with Morrison and Morrison, 1922: 81, Fig. 27).

Key to instars of *Cryptes baccatus* (Maskell)

It was possible to separate instars on a number of morphological characters. These characters have been used to construct the key presented here. As the adult male is easily distinguished from other instars, it has not been included.

1.	Without wing pads	2
—	With wing pads	6
2.	Dorsal body setae arranged into 2 longitudinal rows, with setae often bent posteriorly	1st instar
—	Dorsal body setae either absent or not as above	3
3.	Dorsum naked	2nd instar female
—	Dorsum with tubular ducts, setae or minute circular pores	4
4.	Dorsum with tubular ducts, but without setae or minute circular pores	2nd instar male
—	Dorsum without tubular ducts, but with setae and minute circular pores	5
5.	Antennae with 7 segments; anal ring with 8 setae	3rd instar female
—	Antennae with 8 segments, segments 3 and 4 occasionally only partly differentiated; anal ring with 16 setae	Adult female

6. Dorsal body setae on head and abdomen; legs and antennae: short, length much less than abdomen, with poorly defined segmentation ..... 3rd instar male

— Dorsal body setae on abdomen only; legs and antennae: long, length subequal to abdomen, segmentation poor but apparent 4th instar male

Discussion

There are no authoritative revisionary treatments of the Australian Coccidae and the most recent world wide review of the family based on female morphology was by Steinweden (1929). Given that the generic classification of the family is in urgent need of revision (De Lotto, 1965), attempts to reclassify the family into natural or related groups have, not surprisingly, met with little success (Williams and Kosztarab, 1972). Speculation on the relationship of *Cryptes* to the rest of the family, based on female morphology, is mostly futile. Suffice to say that nothing in this redescription of the adult female questions the assertion of Morrison and Morrison (1922) or Steinweden (1929) as to the generic status of *Cryptes*. Whether this would remain so after a generic revision of the family is another matter.

The taxonomy of the Coccoidea is still firmly based on female morphology, but males are thought to represent ancestral affinities better, particularly at higher levels of classification (Boratynski, 1970), although they can be of use at an intrafamiial level (Boratynski and Davies, 1971; Davies and Boratynski, 1979; Davies, 1981). In the Coccidae the work by Giliomee (1967) provides a base line for the study of intrafamiial relationships using male morphology. Using 119 characters based on the study of 23 species he was able to separate the species examined into four subfamilies (Giliomee's groups of genera). By using the characters established by Giliomee, it was possible to examine the degree of affinity of *Cryptes* to these genera.

Cryptes shared most features (52–65) with the subfamily Eulecaniinae which includes: *Eulecanium* Cockerell, *Nemolecanium* Borchsenius, *Physokermes* Targioni Tozzetti, *Rhodococcus* Borchsenius, *Palaeolecanium* Sulc, *Phyllostroma* Sulc, *Filippia* Targioni Tozzetti, *Ctenochiton* Maskell, *Ericerus* Signoret, and an unidentified genus. It was the largest and most heterogeneous of the families and considered by Giliomee to be the most primitive.

To test the relationships between subfamilies, Giliomee used Ghauri's (1962) method of analysis to calculate the following:

(a) the number of character states shared by pairs of subfamilies;
(b) the number of character states exclusive to the pairs and;
(c) the number of character states by which the two subfamilies differ from each other.

A similar method was followed to examine the relationships of *Cryptes* to Giliomee's subfamilies (Table 3). These data confirm the affinity of *Cryptes* to Eulecaniinae. It shared more character states with this subfamily than any other, and it shared four exclusive character states with the Eulecaniinae compared with none or one shared with other subfamilies. However, *Cryptes* also shows two character states considered by Giliomee to be exclusive to other subfamilies. The postocular ridge does not fork in *C. baccatus*, a feature found only in the Eriopeltinae and *C. baccatus* has lost the basalare, a character state Giliomee considered to be diagnostic of the Coccinae.

The number of character states shared by *Cryptes* and the Eulecaniinae was greater than any other pair of subfamilies examined by Giliomee and similarly the number of differentiating character states was less then for any other pair (Giliomee, 1967: Table 2A). *Cryptes* can not be included in the Eulecaniinae, as defined by Giliomee because of attributes considered exclusive to other subfamilies. Giliomee stressed that his findings were provisional, given the limited number of species used in the analysis. In particular the Eulecaniinae was the most diverse and artificial, so it is hardly surprising given this, and considering that the work was based on European species, that while *Cryptes* showed close affinity to the subfamily, the genus could not be properly included within it.

Unique conditions during the evolution of the Australian phytofauna, particularly the (evolutionary) recent and extensive radiation of *Acacia* and *Eucalyptus* (Myrtaceae) (Gill, 1975), provided an ideal situation for diffuse coevolution (Fox, 1981) to occur (New, 1983). It has been postulated that this can lead to the evolution of many taxonomically difficult groups (New, 1983). Whether the situation with *Cryptes* is a reflection of this or more simply the poor

Table 3. Relationship between *Cryptes* and subfamilies of coccid genera based on Giliomee (1967). See text for explanation.

Pairing	Number of Character States (a) Shared	(b) Exclusive	(c) Differentiating
Cryptes–Eulecaniinae	20	4	3
Cryptes–Eriopeltinae	18	1	10
Cryptes–*Inglisia**	13	0	20
Cryptes–Coccinae	10	1	21

* Only a single species was contained in Giliomee's (1967) *Inglisia*-group and so it has not been raised to subfamily status here.

state of our knowledge of the coccids is uncertain. The analysis of the male presented here, while giving a better indication of the affinities of the genus then possible from study of the female, still was inconclusive. The long term status of the genus depends very much on the extent of revisionary work to be done both on the Australian fauna and world wide. In a recent review Williams (1985) has predicted that many Australian mealybugs (Pseudococcidae) are yet to be discovered and described. It is not unreasonable to believe that a similar situation exits in the Coccidae. Until such revisionary work is done on the Coccidae, the status and position of *Cryptes* within the family will remain uncertain.

Acknowledgments

I thank Dr T. New (Department of Zoology, La Trobe University) for his help and advice during this project and for his critical reading of the manuscript. My thanks to Jenny Lawther for her help and good humour in preparing the illustrations through the early hours of many a cold winter's night. Comments on the manuscript by an anonymous referee are greatly appreciated. Part of this work was done while holding a Commonwealth Postgraduate Research Scholarship.

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Appendix

Abbreviations used in figures. aas, ante-anal setae. ads, abdominal dorsal setae. aed, aedeagus. al, alar lobe. anp, anterior notal wing process. apar, anterior postalar ridge. as, abdominal sternite. ase, differentiated apical setae. avs, abdominal ventral setae. bma, basal membranous area. bra, basal rod of aedeagus. bs, sensilla basiconica. ca, cranial apophysis. cb, coxal bristle(s). ce, caudal extention. cl, claw. cx, coxa. dhs, dorsal head setae. dps, dorsopleural setae. dse, dorsal simple eyes. epm2, mesepimeron. epm3, metepimeron. eps2, mesepisternum. eps3, metepisternum. f, furca. FIII–X, flagellum segments – 3rd to 10th. fm, femur. fs, fleshy setae. g, gena. gp, glandular pouch. h, hamulohaltere. lmcr, lateral arm of midcranial ridge. lpl, lateropleurite. mc, median crest. mdr, median ridge. med, marginal ridge. mr, marginal ridge. mts, metatergal setae. o, ocellus. ocs, ocular sclerite. pa, postalare. pcr2, precoxal ridge of mesothorax. pcr3, precoxal ridge of metathorax. pdc, pedical. pepcv, proepisternum + cervical sclerite. pla3, metapleural apophysis. plr1, propleural ridge. plr2, mesopleural ridge. plr3, metapleural ridge. pn2, mesopostnotum. pn3, metapostnotum. pna, postnotal apophysis. pnp, posterior notal wing process. pocr, postocular ridge. pra, prealare. prnr, pronotal ridge. procr, preocular ridge. pror, preoral ridge. prsc, prescutum. ps, penial sheath. pscr, prescutal ridge. pscs, prescutal suture. pwp, mesopleural wing process. rad, radius. scl, scutellum. sclf, scutellar foramen. scp, scape. sct, scutum. ser, subepisternal ridge. set,scla, subapical sensory setae. sp2, mesothoracic spiracle. sp3, metathoracic spiracle. stn1, prosternum. stn2, mesosternum (basisternum). stn3, metasternum. stn1r, prosternal ridge. tar, tarsus. tdgt, tarsal digitules. teg, tegula. tegs, tegular setae. tib, tibia. tibs, tibial spur. tp, triangular plate. tr, trochanter. ts, tail setae. udgt, ungual digitules. vhs, ventral head setae. vmcr, ventral arm of micdcranial ridge. vps, ventropleural setae. vse, ventral simple eyes.

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THE FAMILY PSYCHOMYIIDAE (TRICHOPTERA) RE-ESTABLISHED IN AUSTRALIA

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Abstract

Neboiss, A., 1990. The family Psychomyiidae (Trichoptera) re-established in Australia. *Memoirs of the Museum of Victoria* 51(1): 83–86.

The family Psychomyiidae is re-established in the Australian Trichoptera fauna represented by *Tinodes radona* sp. nov. from Kakadu National Park, NT, and a north-eastern Queensland species tentatively referred to the New Zealand genus *Zelandoptila*, *Z. yuccabina* sp. nov.

Introduction

The family Psychomyiidae s.l. was first recorded from Australia by Mosely and Kimmins (1953) who reported the genera *Ecnomus* and *Ecnomina*. Subsequently, Riek (1970) incorporated all polycentropodids, stenopsychids and ecnomids in Psychomyiidae. This was changed when Neboiss (1977) following proposals of Ulmer (1951), Lepneva (1956) and Schmid (1969), recognized these three groups as separate families and removed Psychomyiidae from the Australian Trichoptera. Recent discovery of a member of the genus *Tinodes* in Northern Australia re-establishes the family firmly on the Australian continent and comes as no surprise as the genus *Tinodes* is already known from New Guinea (Kimmins, 1962). Another species from north-eastern Queensland is tentatively referred to the New Zealand genus *Zelandoptila* although it conflicts in several respects with the generic definition.

The following abbreviations are used for the institutions where specimens are deposited: ANIC, Australian National Insect Collection, Canberra; NMV, Museum of Victoria, Melbourne.

Psychomyiidae Curtis

Psychomidae Curtis, 1835: 561 (text).

Diagnosis. (Modified after Wiggins, 1982) Ocelli absent. Maxillary palpi 5-segmented in both sexes (6-segmented in Padunellinae, not known from Australia); segment 1 short, segment 2 about as long as or longer than segment 1, segment 3 as long as segment 2 or segments 1 and 2 together, never inserted before the apex of segment 2, segment 4 as long as or shorter than segment 3, segment 5 about as long as segments 3 and 4 together, annulate, flexible. Antennae moderately robust, not exceeding the length of fore wing, scape shorter than head, only slightly thicker than following segments. Mesoscutum with pair of ovoid warts, scutellum with setal warts either separate or fused. In some genera females with mid-legs dilated. Claws normal. Spurs 2:4:4 (some genera may be 1:2:4 or 1:4:4).

Wings slender, rounded or tapered apically. Fore wings fork 1 absent, discoidal cell short, median cell usually closed, thyridial cell very small, situated close to wing base and more or less separated from the base of median cell. Hind wing narrow, lanceolate, costal margin more or less produced anteriorly at middle, fork 1 absent, forks 2, 3 and 5 usually present, fork 3 sometimes absent, discoidal cell open.

Tinodes Curtis

Tinodes Curtis, 1834: 216.

Type species. Tinodes lurida Curtis, 1834 (= *Phryganea waeneri* Linnaeus, 1758 (by monotypy).

Diagnosis. Maxillary palpi with segment 3 about as long as segment 2, segment 4 shorter than segment 3. Mid-legs of females not dilated. Spurs 2:4:4.

Fore wings moderately slender, rounded apically, discoidal cell relatively broad, apical forks 2, 3, 4 and 5 present, fork 2 sessile, forks 3 and 4 with footstalk, median cell open in Australian and New Guinea species (closed in European species), thyridial cell small, distinctly separated from base of median cell (fork). Hind wing rather narrow, costal margin at apical half slightly concave, projection at middle small, R1 connected to R2 by cross-vein, fork 3 present,

sessile, 2 anal veins run separately along their entire length.

Male genitalia with inferior appendages robust; in females abdomen ends in more or less extended ovipositor.

Tinodes radona sp. nov.

Figures 1–4

Type material. Holotype ♂, Northern Territory, Radon Springs, 12°45′S, 132°55′E, light trap, 13 Apr 1989, A. Wells and P. Suter (NMV T-10484).

Paratypes: 1♂ 1♀, collected with holotype (genitalia prep. PT-1814♂, PT-1815♀ figured) (NMV T-10485, T-10486); 1♂, North Queensland, Gordon Creek, Iron Range, 2 Jun 1975, M.S. Moulds (NMV T-10487); 16♂ 2♀, 3–13 km ENE of Mt Tozer, 12°43′S, 143°18′E, MV-light, 28 Jun–13 Jul 1986, J.C. Cardale et al. (ANIC; NMV).

Other material examined: 1♂, North Queensland, 1 km SE of Mt Cook, Cooktown, 13 Oct 1980, J.C. Cardale (ANIC).

Description. Adults preserved in alcohol, general colour including legs and antennae yellowish to greyish brown. Male genitalia: tergite 9 with long and narrow ventrolateral extensions, segment 10 membranous and vestigial, sternite 9 strongly sclerotised, ventral margin extended distally. Preanal appendages long, slightly curved, inserted together with end of ventrolateral extension of tergite 9, a small lateral tubercle near base. Intermediate appendages strongly developed, attached to upper section of sternite 9, lateral sclerites flattened, extended distally, armed mid-dorsally with 3 long, slightly curved spiny setae and apically with several long and a group of shorter spiny setae. Inferior appen-

Figures 1–4. *Tinodes radona* sp. nov. 1, male paratype T-10485, genitalia lateral; inf, inferior appendages; int, intermediate appendages; pa, preanal appendages; ph, phallus; phg, phallic guide; phs, phallic sclerite. 2, male genitalia ventral. 3, male wing venation. 4, end segments of female abdomen paratype T-10486.

dages robust, broad, fused mesoventrally near base, terminating with 2 apically pointed branches, ventral margin with several short, pointed teeth, ventrally directed, digitiform process arises from mesal surface at base of apical branches. Phallic structure membranous, situated between and above intermediate appendages, phallic sclerite flattened dorsoventrally, situated near apex.

Female: abdominal segment 8 composed of distinct tergite and sternite, segment 9 elongate, tapering distally, segment 10 short, rounded apically, terminating with pair of small cerci.

Length of fore wing: ♂ 3.1–3.4mm, ♀ 3.6–3.8 mm.

Distribution. Northern Australia (Arnhem Land and Cape York Peninsula).

Etymology. The name refers to the type locality, Radon Springs, Kakadu National Park.

Remarks. Male genitalia resemble those of *Tinodes aberrans* Kimmins of New Guinea but may be distinguished by row of strong, acute teeth along the ventral margin of inferior appendages.

Zelandoptila Tillyard

Zelandoptila Tillyard, 1924: 300.

Type species. Zelandoptila moselyi Tillyard (by monotypy).

Diagnosis. Head wider than long. Maxillary palpi with segment 1 short, about as long as wide, segment 2 about as long as segment 1, segment 3 and 4 slender, each about as long as segments 1 and 2 together, segment 5 annulate, flexible. Scutellum with setal warts apparently fused. Spurs 2:4:4 (Australian species) or 1:2:4 (New Zealand species).

Wings slender, narrowly rounded apically. Fore wing with discoidal cell and apical forks 2 and 3 present, median cell open, thyridial cell basal to medial fork, or at most, just touching. Hind wing with costal margin slightly produced anteriorly at middle, Sc extends beyond middle without cross-vein to R, discoidal cell open, forks 2, 3 and 5 present, anal area narrow.

Remarks. Irrespective of some deviation from the generic characters described for the New Zealand genus, the general characteristics of both insects are so similar that a separate generic placement for the Australian species is not warranted.

Tillyard (1924) proposed the genus *Zelandoptila* for species *moselyi* in the family Hydroptilidae, commenting that "... this remarkable genus has no near relatives in any part of the world, and must be considered as a very primitive Hydroptilid type." In 1956 McFarlane described *Zelomyia trulla* in the Psychomyiidae, but later (McFarlane, 1964) recognized this as a synonym of Tillyard's *Zelandoptila moselyi* in the Hydroptilidae. McFarlane (1964) examined Tillyard's unique type specimen, a female, and noted that both wings were incorrectly figured, they actually agree with figures given for *Zelomyia trulla*. The absence of cross-veins is particularly noticeable in Tillyard's figures. Further amendments were suggested and new drawings of wing venation were prepared which differed from the previously published versions (McFarlane, in litt. 1976). It is still not clear whether the fore wing median and thyridial cells and fork 5 are present. Tillyard (1924) gave tibial spurs as "apparently 1, 2, 4" but the formula was not verified by McFarlane (1956, 1964).

The Australian species agree in most characters with the combined descriptions given by Tillyard (1924) and McFarlane (1956). The main discrepancies, however, are the closed thyridial cell, absence of fork 5 in fore wing and the spurs 2:4:4 as in typical psychomyiids.

Zelandoptila yuccabina sp. nov.

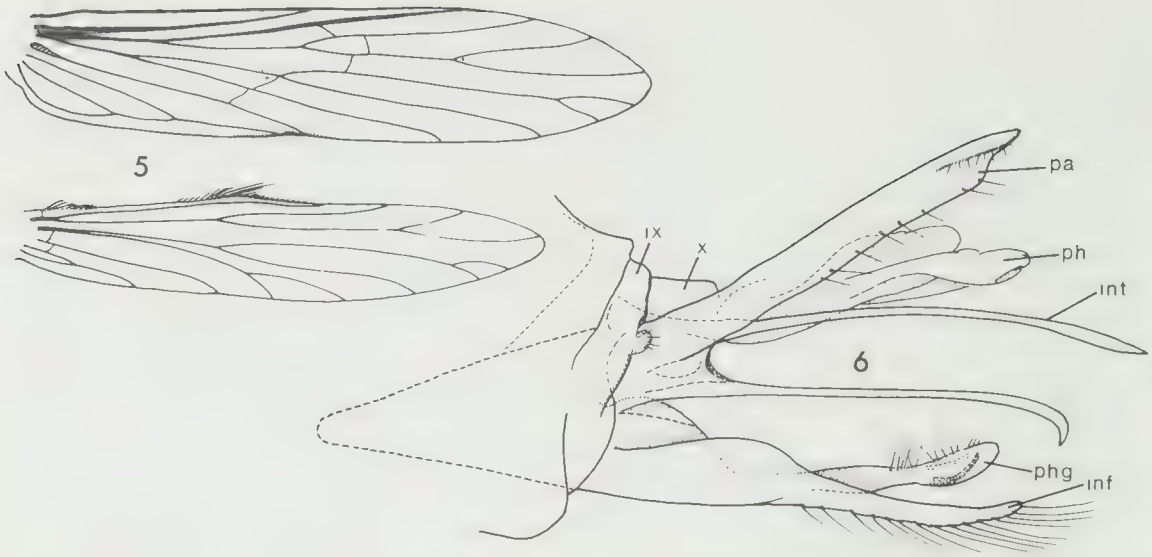
Figures 5, 6

Type material. Holotype ♂, NE Queensland, Yuccabine Creek, Kirrama State Forest, 18°12′S, 145°54′E, Feb 1986, R. Pearson and L. Benson (genitalia prep. PT-1587 figured) (NMV T-10488).

Description. Adult preserved in alcohol, general colour pale yellowish-brown. Male genitalia: segment 9 short, segment 10 membranous, in dorsal view triangular with small apicomesal incision. Preanal appendages long, subparallel, apex with partial twist forming short mesal ridge, a short rounded tubercle basolaterally, ventromesal margins of both sides fused, extended distally into a long, apically hooked process. Intermediate appendages slender, gradually curved, distally slightly dilated before tapering to acute apex. Phallus almost as long as preanal appendages, semimembranous, apex rounded. Inferior appendages fused mesally to form elongate, distally tapered and apically bluntly rounded plate, phallic guide arises from the mesal surface, flattened dorsoventrally, apex turned upwards, deeply incised apically, with two internal chitinous spines.

Female unknown.

Length of fore wing: ♂ 2.4 mm.



Figures 5, 6. *Zelandoptila yuccabina* sp. nov., holotype T-10488. 5, male wing venation. 6, male genitalia lateral.

Distribution. NE Queensland.

Etymology. The species name refers to the type locality Yuccabine Creek, NE Queensland.

Acknowledgments

The author is indebted to Dr R. Pearson, Zoology Department, James Cook University, Townsville and Dr A. Wells, Department of Zoology, University of Adelaide, for the privilege of examining and describing material they collected in North Queensland and Northern Territory respectively.

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Memoirs of the Museum of Victoria 51: 87–92 (1990) ISSN 0814-1827

TRICHOPTERA OF THE FAMILIES GOERIDAE AND LEPIDOSTOMATIDAE FROM SULAWESI, INDONESIA

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Abstract

Neboiss, A., 1990. Trichoptera of the families Goeridae and Lepidostomatidae from Sulawesi, Indonesia. *Memoirs of the Museum of Victoria* 51(1): 87–92.

Descriptions of *Goera skiasma* sp. nov. (Goeridae) and three new species of Lepidostomatidae — *Goerodes tectoris* sp. nov., *G. xylochus* sp. nov. and *G. anorhepes* sp. nov. are given. Both families are recorded for the first time from Sulawesi, Indonesia.

Introduction

This paper is based on material collected at Dumoga-Bone National Park, Northern Sulawesi, by participants of the Project Wallace expedition 1985 and several additional specimens from Lore Lindu National Park, Central Sulawesi. Both families, Goeridae and Lepidostomatidae, although known from Sumatra, Java and New Guinea (Ulmer, 1951; Weaver, 1989) are here reported from Sulawesi for the first time. The family Goeridae is represented by one species, *Goera skiasma* sp. nov., and Lepidostomatidae by three, *Goerodes tectoris* sp. nov., *G. xylochus* sp. nov. and *G. anorhepes* sp. nov. These new species differ clearly from the several lepidostomatids recently reported from Sumatra by Weaver (1989) and those described by Ulmer (1951) from Sunda islands and Kimmins (1962) from New Guinea.

The following abbreviations are used for depositories of material: ANIC, Australian National Insect Collection, Canberra; BMNH, British Museum (Natural History), London; NMV, Museum of Victoria, Melbourne; NTMD, Northern Territory Museum of Art and Sciences, Darwin; RMNH, Rijksmuseum van Natuurlijke Historie, Leiden; ZMB, Zoological Museum, Bogor.

Terminology follows that used by Weaver (1988). All dissected and figured specimens are identified by the author's notebook number with the prefix "PT-".

Goeridae

Goera skiasma sp. nov.

Figures 1–7

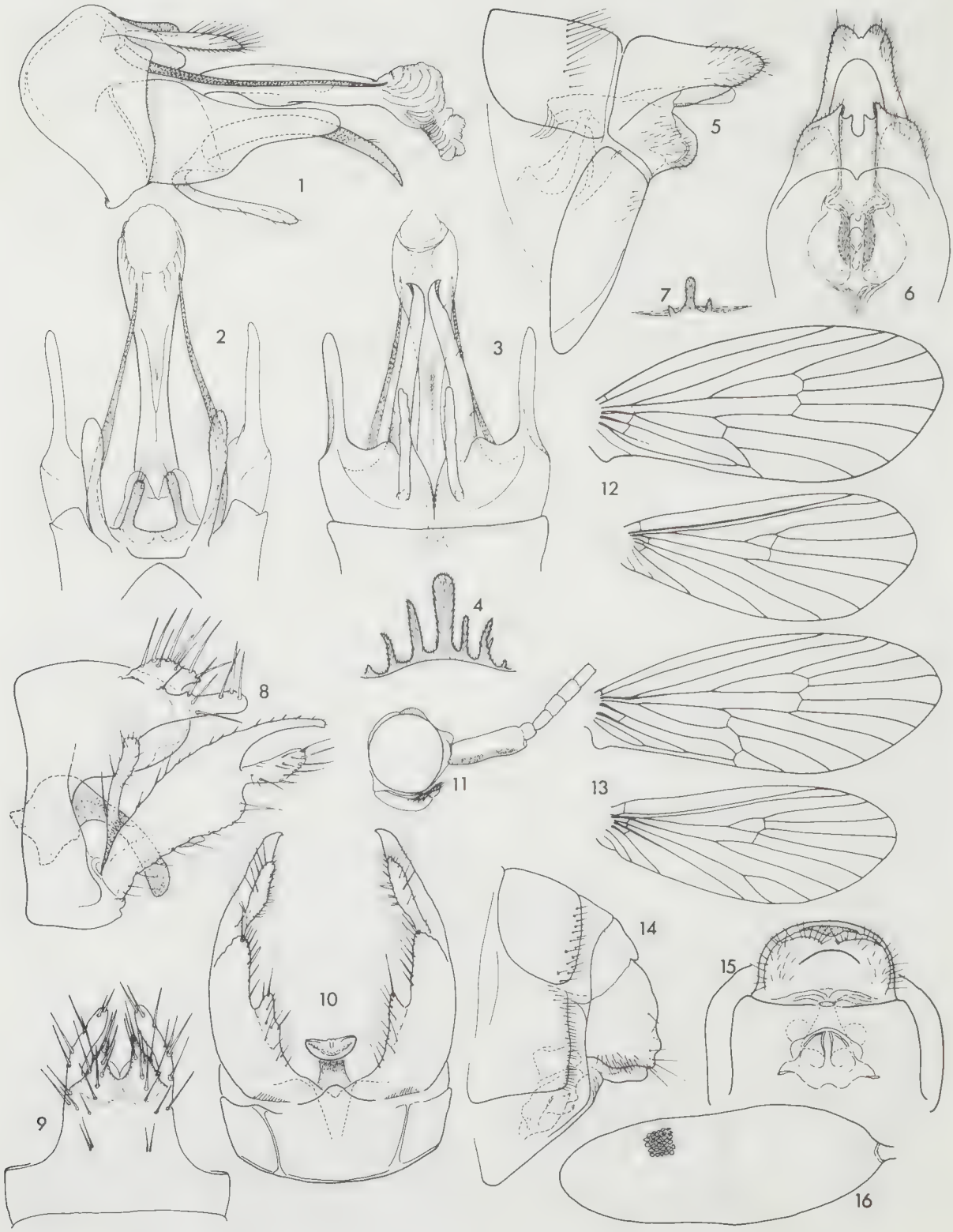
Type material. Holotype ♂, Sulawesi Utara, Dumoga-Bone National Park, Tumpah River and tributary junction, 00°35′N, 123°54′E, 19 May 1985, A. Wells, M. Wilson, M.W. Tan (NMV T-10420).

Paratypes: 1♂, collected with holotype (genitalia prep. PT-1530 figured) (NMV); 1♂, Edwards Camp, Tumpah River, alt. 650 m, MV-light, 28 Apr 1985, J. Martin and M. Horak (NMV); 2♂, 1440 Camp, 00°37′N, 123°51′E, 9–14 May 1985, J. Martin and M. Horak (BMNH, NMV); 1♂, Toraut River, Aug 1985, D. Dudgeon (ZMB); 1♂ 1♀, Beach on Tumpah River, Picnic site, alt. 225 m, MV-light, Oct 1985, M. Malipatil (genitalia prep. PT-1810♀ figured) (NMV); 1♂, Base Camp, Toraut River cleared area, alt. 211 m, MV-light, 4 Oct–8 Nov 1985, M. Malipatil (NTMD); 1♂, Palu, 50 km SE of Lore Lindu National Park, Dongi Dongi shelter, alt. 950 m, 4 Dec 1985, J. van Tol and J. Krikken (RMNH); 1♂, same locality, 9 Dec 1985, J. van Tol and J. Krikken (RMNH).

Diagnosis. Adults yellowish-brown to brown, resembling *Goera minor* Mosely of Burma. Males distinguished by broad, bifid, mesolateral lobe of inferior appendages, females by the mesodistally marginate sternite 9 and distinctly excavated distal margin of vulvar plate.

Length of fore wing: ♂ 7.1–8.1 mm, ♀ 8.5 mm.

Description. Male: Scape fusiform; maxillary palpi adpressed, apparently 2-segmented, membranous, widest distally, densely covered with closely adherent hairs, an additional membranous branch arises at base. Abdominal sternite 6 with distinct transverse ridge; mesal comb formed of 7 prongs, the central one rounded apically (Fig. 4.). Genitalia (Figs 1–3). Segment 9 in lateral view widest at dorsal third, narrowed ventrally, mid-dorsal excavation broad; dorsomedian lobes digitiform, preanal appendages robust; intermediate appendages long, slender, pointed distally. Segment 10 membranous, short, bilobed distally. Inferior appendages



Figures 1–7. *Goera skiasma* sp. nov., PT-1530: 1, male genitalia lateral. 2, dorsal. 3, ventral. 4, mesal comb of male abdominal sternite 6. PT-1810: 5, female genitalia lateral. 6, ventral. 7, mesal comb of female abdominal sternite 6. ►

broad at base, expanded mesolaterally into a broad lobe from which arise 2 branches: 1 elongate dorsal branch, tapering to acute apex and shorter ventral branch, curved, digitiform, bluntly rounded at apex. Phallus long, robust, membranous distally.

Female: Abdominal sternite 6 with transverse ridge, mesal comb small, formed of 3 prongs, the central robust, lateral prongs small (Fig. 7). Sternite 8 extended dorsoventrally. Tergites 9 and 10 fused (Fig. 5); supragenital plate sclerotised, rounded apically; sternite 9 short, with distally pronounced mesal margin; distal margin of vulvar plate in ventral view distinctly indented mesally (Fig. 6).

Distribution. Sulawesi, Indonesia.

Etymology. From *skiasma* (Greek), a shadow, in reference to the species' generally dark appearance.

Lepidostomatidae

Goerodes tectoris sp. nov.

Figures 8–16

Type material. Holotype ♂, Sulawesi Utara, Dumoga-Bone National Park, Edwards Camp, Tumpah River, 00°35′N, 123°51′E, alt. 650 m, MV-light, 22 May 1985, A. Wells (NMV T-10426,).

Paratypes: 2♂ 1 ♀, collected with holotype (NMV); 1♂ 7♀, same locality, 28 Apr 1985, J. Martin and M. Horak (genitalia prep. PT-1539♂, PT-1805♀ figured) (NMV); 6♂, same locality, 8 May 1985, J. Martin (ANIC, BMHN, ZMB); 2♂, same locality, alt. 664 m, 22–23 Oct 1985, M. Malipatil (NTMD); 1♂, Tumpah River tributary, first fall, 00°36′N, 123°54′E, 4 May 1985, A. Wells (NMV); 1♂, Hog's Back Camp, 00°35′N, 123°52′E, alt. 492 m, MV-light, 2 Oct–4 Nov 1985, M. Malipatil (NMV); 1♂, Motolanga River Dolodua-Malibagu Road, 00°28′N, 123°58′E, 7 May 1985, A. Wells (NMV).

Diagnosis. Adults pale yellowish; fore wings broad, rounded apically without folds, venation differing between sexes in Cu-A region (Figs 12, 13). Male genitalia similar to other *Goerodes* species described from Java and Sumatra, but differ in the short, robust and coarsely spinose segment 10.

Length of fore wing: ♂ 4.7–5.3 mm; ♀ 5.5–6.2mm.

Description. Male: Scape about as long as the diameter of eye (Fig. 11), cylindrical, mesofrontal surface more or less darkly pigmented. Maxillary palpi 2-segmented, adpressed to face, segment 2 very short, apical half of inner surface setose. Genitalia (Figs 8–10). Segment 9 annular, slightly produced midventrally. Segment 10 short, robust, spinose dorsally; lateral processes symmetrical, short, rounded apically, in dorsal view converging distally; dorsomesal processes short, subtriangular in dorsal view. Inferior appendages in ventral view broad-based, in lateral view widest at distal two thirds, bilobed apically; apicodorsal lobe slightly curved, tapering distally, apex blunt; apicoventral lobe robust, setose, rounded apically; basidorsal process digitiform, rather robust. Phallus without parameres, phalicata at about right angle with base.

Female: (Figs 14, 15) Abdomen terminating bluntly. Segment 8 with shallow lateral depressions; spermathecal sclerite subtriangular in ventral view; spermatheca (Fig. 16) elongate-ovoid, anterior half with scale-like microstructure, denser and more distinct towards the anterior end.

Distribution. Sulawesi, Indonesia.

Etymology. From *tector* (Latin), a coverer, referring to the adpressed maxillary palpi in the male.

Goerodes xylochus sp. nov.

Figures 17–21

Type material. Holotype ♂, Sulawesi Utara, Dumoga-Bone National Park, Edwards Camp, Tumpah River, 00°35′N, 123°51′E, alt. 650 m, MV-light, 28 Apr 1985, J. Martin and M. Horak (NMV T-10441,).

Paratypes: 2♂, collected with holotype (genitalia prep. PT-1540 figured) (NMV); 1♂, same locality, alt. 664 m, 22–23 Oct 1985, M. Malipatil (NTMD).

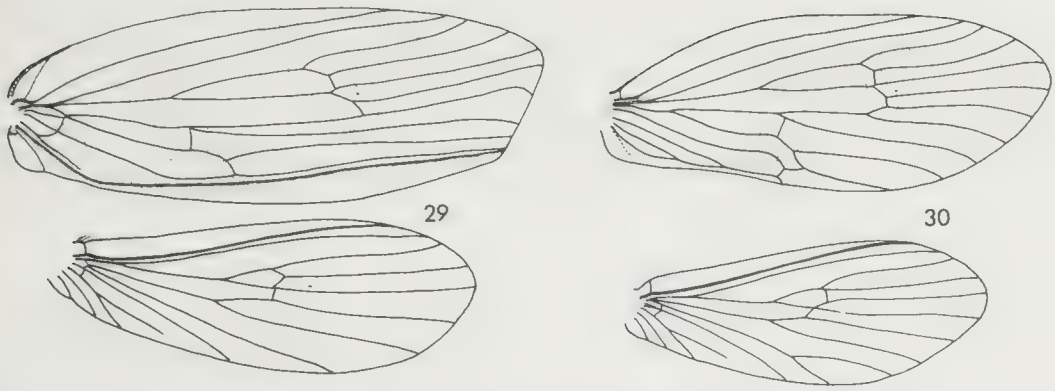
Diagnosis. Adults pale yellowish; fore wings broad, rounded apically without folds, venation regular (Fig. 21). Closely similar to *Goerodes tectoris* sp. nov. from Sulawesi, but distinguished by mesolaterally excavated scape and large, densely setose maxillary palps.

Length of fore wing: ♂ 5.3–5.5 mm.

Description. Male: Scape about 1.5 times as long as the diameter of eye; mesofrontal cavity elongate, darkly pigmented, densely covered with long, dark hair (Fig. 20). Maxillary palpi long,

◄ Figures 8–16. *Goerodes tectoris* sp. nov., PT-1539: 8, male genitalia lateral. 9, dorsal. 10, ventral. 11, male head lateral. 12, male wing venation. PT-1805: 13, female wing venation. 14, female genitalia lateral. 15, ventral. 16, spermatheca.

Figures 17–21. *Goerodes xylochus* sp. nov., PT-1540: 17, male genitalia lateral. 18, dorsal. 19, ventral. 20, male head lateral. 21, wing venation. ►



Figures 29, 30, *Goerodes anorhepes* sp. nov. wing venation. 29, male. 30, female.

densely setose, basal setae somewhat elongate spatulate; apical segment extends above the frons and correspondingly matches the curvature of the elongate cavity of the scape. Genitalia (Figs 17–19). Segment 9 annular with small projection midventrally. Segment 10 robust, spinose dorsally; lateral processes symmetrical, short, rounded apically, in dorsal view slightly curved, converging distally; dorsomesal processes short, subtriangular in dorsal view. Inferior appendages in ventral view broad based, in lateral view widest medially, bilobed apically; apicodorsal lobe slightly curved, apex truncate in lateral view; apicoventral lobe widest at basal third, setose, rounded apically, shorter than apicodorsal lobe; basidorsal process digitiform, slender. Phallus without parameres, phalicata at about right angle with base.

Female: unknown.

Distribution. Sulawesi, Indonesia.

Etymology. From *xylochos* (Greek), a thicket, referring to dense coverage of hairs on scape and maxillary palps.

Goerodes anorhepes sp. nov.

Figures 22–30

Type material. Holotype ♂, Sulawesi Utara, Dumoga-Bone National Park, Edwards Camp, Tumpah River, 00°35′N, 123°51′E, alt. 650 m, MV-light, 28 Apr 1985, J. Martin and M. Horak (NMV T-10444,).

Paratypes: 7♂ 3♀, collected with holotype (genitalia prep. PT-1541♂, PT-1809♀ figured) (NMV); 1♂ 4♀, same locality, 8 May 1985, J. Martin (NMV); 3♂ 2♀, same locality, alt. 664 m, 22–23 Oct 1985, M. Malipatil (BMNH, NTMD); 1♀, Barney's Camp, alt. 302 m, 4 Oct–8 Nov 1985, M. Malipatil (NTMD); 2♂, Hog's Back Camp, 00°35′N, 123°52′E, alt. 492 m, 21 Oct–4 Nov 1985, M. Malipatil (NTMD); 2♂ 6♀, 1440 Camp, 9-14 May 1985, J. Martin and M. Horak (ANIC, NMV); 1♂, Tumpah River, Aug 1985, D. Dudgeon (ZMB).

Diagnosis. Adults greyish-brown, fore wings with pale, oblique band at apicocostal margin and at anastomoses. Male fore wing (Fig. 29) unlike those of other Sunda Island species, obliquely truncate apically, female rounded (Fig. 30). Scape of male antenna with with distinct, darkly pigmented, setose depression.

Length of fore wing: ♂ 8.1–8.8 mm; ♀ 7.2–7.6 mm.

Description. Male: Scape slightly longer than twice the diameter of eye (Fig. 25), widest at distal quarter; mesofrontal cavity ovoid, darkly pigmented, bearing numerous erect setae; inner margin elevated to short, apically truncate protuberance. Maxillary palp 2-segmented, slender, adpressed to face, apex fitting within the depression of the scape; apical segment semi-membranous, covered with long, dense hair. Genitalia (Figs 22–24). Segment 9 annular, slightly wider ventrally. Segment 10 short, symmetrical; lateral processes slender, shorter than dorsomesal pair, both tapering distally. Inferior appendages in lateral view widest at apical third; apices bilobed; apicoventral lobe robust, rounded, apically densely setose; apicodorsal lobe tapering distally, slightly curved downward; a small,

◄ Figures 22–28. *Goerodes anorhepes* sp. nov., PT-1541: 22, male genitalia lateral. 23, dorsal. 24, ventral. 25, male head lateral. PT-1809: 26, female genitalia lateral. 27, ventral. 28, spermatheca.

slightly clavate mesal process at right angles to the inferior appendage; basidorsal process expanded distally. Phallus without parameres, slightly curved.

Female: Sternite 8 laterally (Fig. 26) with internal longitudinal ridge, venter somewhat flattened with a narrow strongly sclerotised transverse bar situated near anterior margin; spermathecal sclerite broad in ventral view (Fig. 27); spermatheca (Fig. 28) elongate ovoid, anterior half covered with scale-like microstructure, more distinct at apex.

Distribution. Sulawesi, Indonesia.

Etymology. From *rhepo* (Greek), an incline or slope, referring to the obliquely truncate tip of the male fore wing.

Acknowledgments

I am most grateful to Dr Alice Wells of the Department of Zoology, University of Adelaide, for providing most of the material and valuable criticism, also to Drs D. Dudgeon of Hong Kong, Jan van Tol of Leiden and M. Malipatil of Darwin (now of Melbourne) for the loan of other important material.

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TYLOS BILOBUS SP. NOV., A SECOND AUSTRALIAN SPECIES OF TYLIDAE (CRUSTACEA: ISOPODA: ONISCIDEA)

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Abstract

Lewis, F., 1990. *Tylos bilobus* sp. nov., a second Australian species of Tylidae (Crustacea: Isopoda: Oniscidea). *Memoirs of the Museum of Victoria* 51(1): 93–97.

Tylos bilobus sp. nov. is described from specimens collected from three Queensland beaches. The new species differs from the recently described *Tylos australis* Lewis and Bishop (1990) by a lobed telson and a triangular frontal process.

Introduction

This second Australian species of *Tylos* is described from specimens collected from three beaches in Queensland: Clairview, south of Mackay, Cardwell, north of Townsville and Tin Can Bay, south of Maryborough. Until recently the infraorder Tylomorpha was considered to contain one family, Tylidae, with two genera, *Tylos* Latreille, 1826 and *Helleria* Ebner, 1868 (Holdich et al., 1984). Now, it has been suggested that the Tylidae should be reclassified in the section Crinocheta as one of the three families of the superfamily Scyphacoidea (Schmalfuss, 1989). Three Australian species of *Tylos* have been collected within the last three years, *T. australis* (Lewis and Bishop, 1990) from the New South Wales and Victorian coasts, the species described here from the eastern Queensland coast, and a third from Western Australia (Lewis, in press).

The following abbreviations are used: AM, Australian Museum, Sydney; TM, Tasmanian Museum and Art Gallery, Hobart; QM, Queensland Museum, Brisbane; MU, Macquarie University, Biological Sciences Museum, Sydney.

Tylidae

Tylos Audouin, 1826

Type species. Tylos latreillei Audouin, 1826.

Diagnosis. (Adapted from Schmalfuss and Ferrara, 1978). Able to roll up into perfect ball; head with triangular protrusion between antennae and lateral quadrangular grooves into which antennae fit when animal is rolled up; antenna 1 of 1 article; antenna 2 with 4-articled flagellum; pereonite 1 with ventral grooves in the epimera (locking mechanism when conglobating); pleonal tergites not fused (fused in *Helleria*); pleonal epimera forming ventral plates (phylacomeres) covering part of ventral surface of pleon; pleopodal exopods with tracheal system; only pleopod 2 endopod modified as male copulatory organ; uropods completely ventral, with terminal endopod, exopod obsolete.

Remarks. The genus *Tylos* currently contains 24 species (Roman, 1977; Schultz, 1983; Lewis and Bishop, 1990) of which nine are from the southern hemisphere. With the exception of *Tylos latreillei* the other species of *Tylos* have a restricted distribution. The species are distinguished by variations in the shape of the frontal process, the shape and ornamentation of the telson, the shape of the lateral border of the first epimeron and the shape of the fifth pleon plate.

Tylos bilobus sp. nov.

Figures 1–3

Type material. Holotype male, Clairview Beach, Queensland (22°07′S, 149°32′E), from under debris along high tide line, Aug 1988, Fiona Lewis, AM P39118.

Paratypes. Collection data as for holotype, AM P38911 (2 males, 2 females). Cardwell Beach, Queensland (18°10′S, 146°01′E), from under debris along high tide line, Fiona Lewis, Aug 1988, TM G3286 (2 males, 2 females), QM W15792 (2 males, 2 females), MU (2 males, 2 females).

Diagnosis. 2 raised lobes on the telson, prominent triangular frontal process, evenly convex lateral border of epimeron 1, straight medial margin of fifth pleon plate.

Description (of holotype except where indicated). Length 10 mm, breadth 4.5 mm.

Colour (live). Dorsal surface creamy-grey with very small black chromatophores scattered

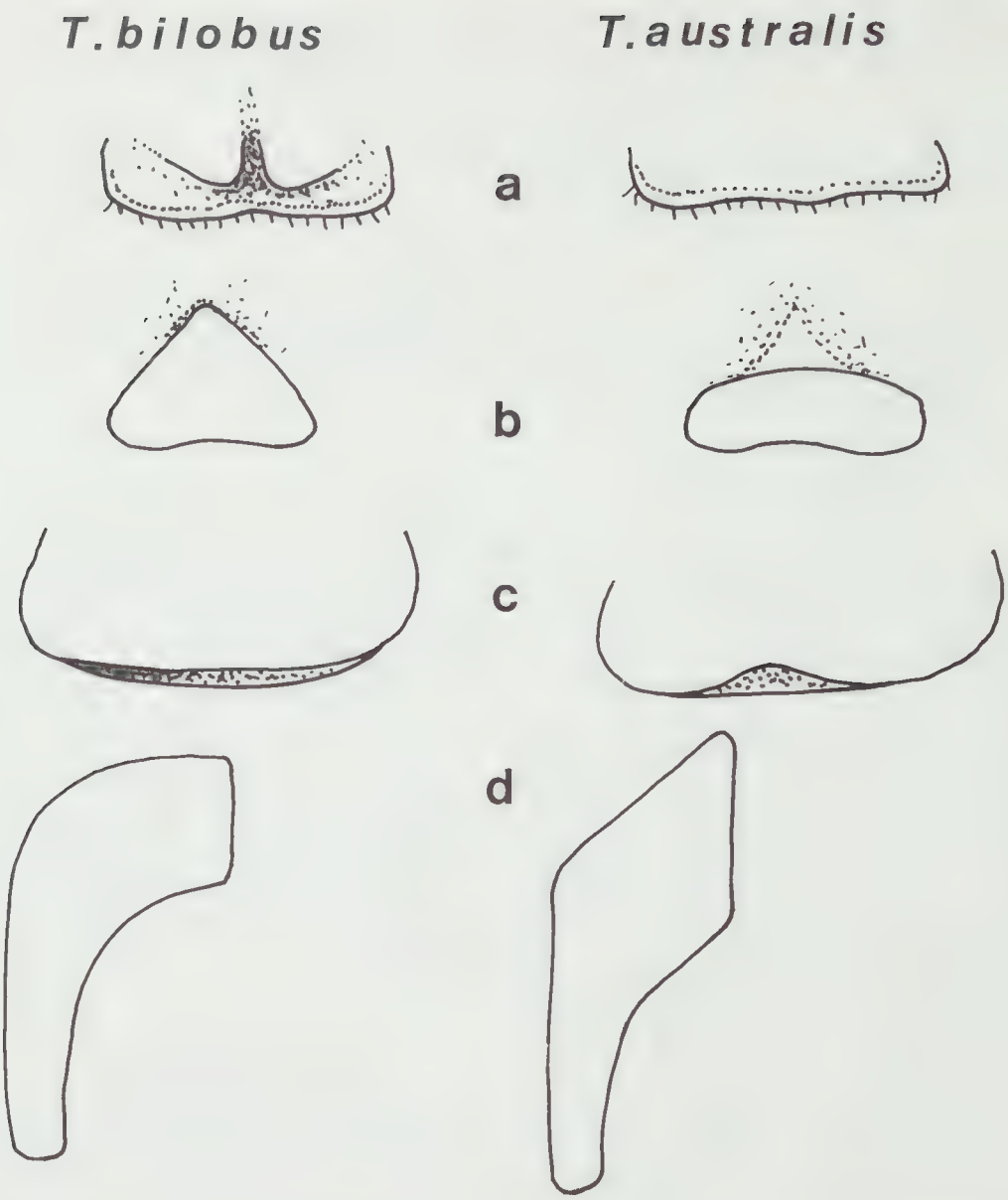

Figure 1. Differences between *Tylos bilobus* sp. nov. and *T. australis* Lewis and Bishop, 1990. a, telson. b, frontal process. c, epimeron 1. d, pleon plate 5.

along the posterior pereonite borders, sparse elsewhere; few on antennae and none on pereopods. Some specimens with denser chromatophores on pereonites 4 and 5.

Cephalon. Eyes each of 35–36 ocelli. Vertex without distinct frontal line but with slightly raised areas adjoining and median to eyes; frontal process broadly triangular with apex sharply joining cephalon; clypeus distinctly tuberculate and spinose.

Antenna 1 medial to and slightly above antenna 2 base, of 1 immobile, triangular article. Antenna 2 short and stout; flagellum of 4 articles, 0.2, 0.2, 0.5 and 0.05 mm long, terminal

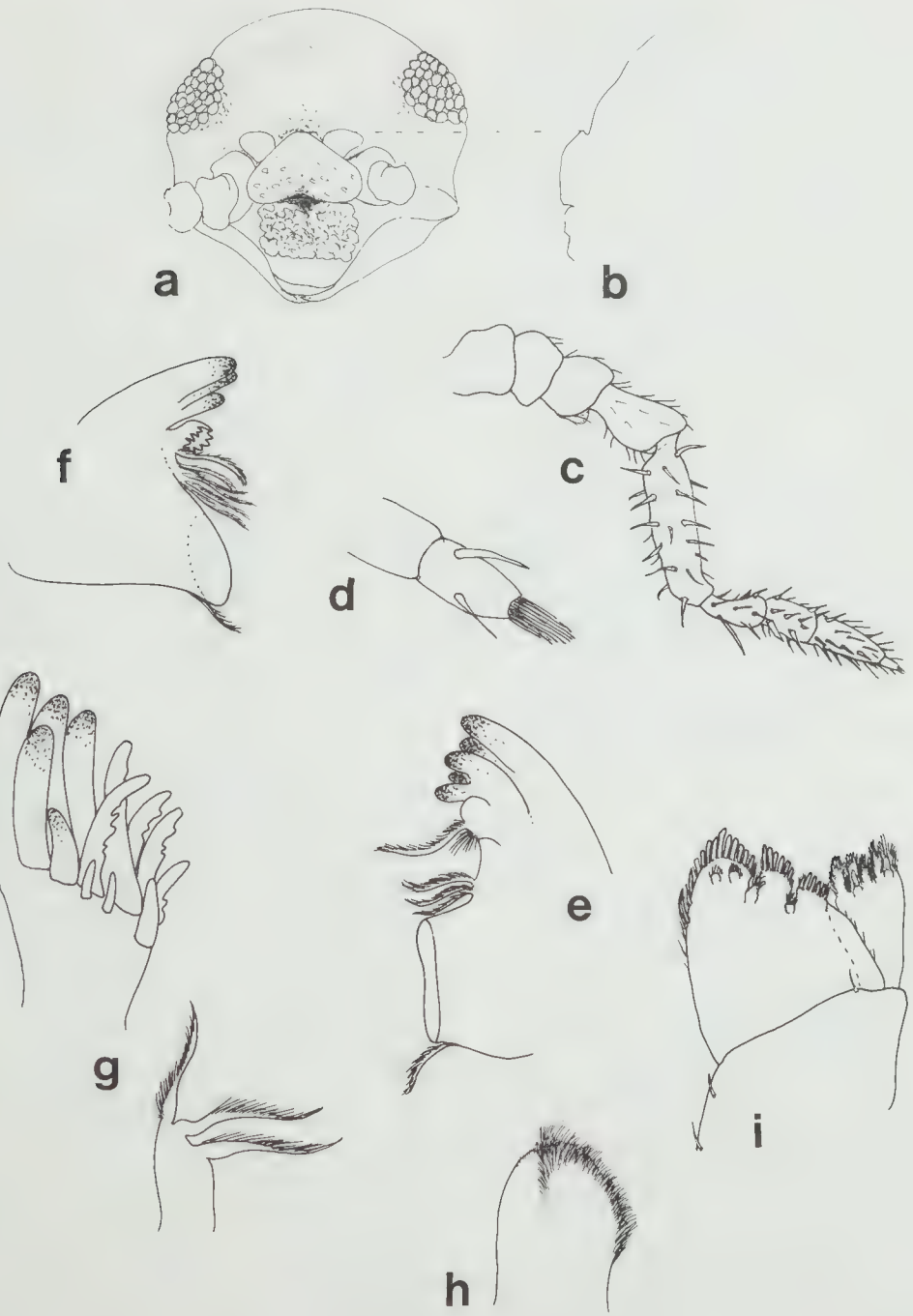

Figure 2. *Tylos bilobus* (holotype): a, anterior view of cephalon. b, lateral view of cephalon. c, antenna 2. d, flagellar article 4. Paratype male, similar size: e, left mandible. f, right mandible. g, maxilla 1. h, maxilla 2. i, maxilliped.

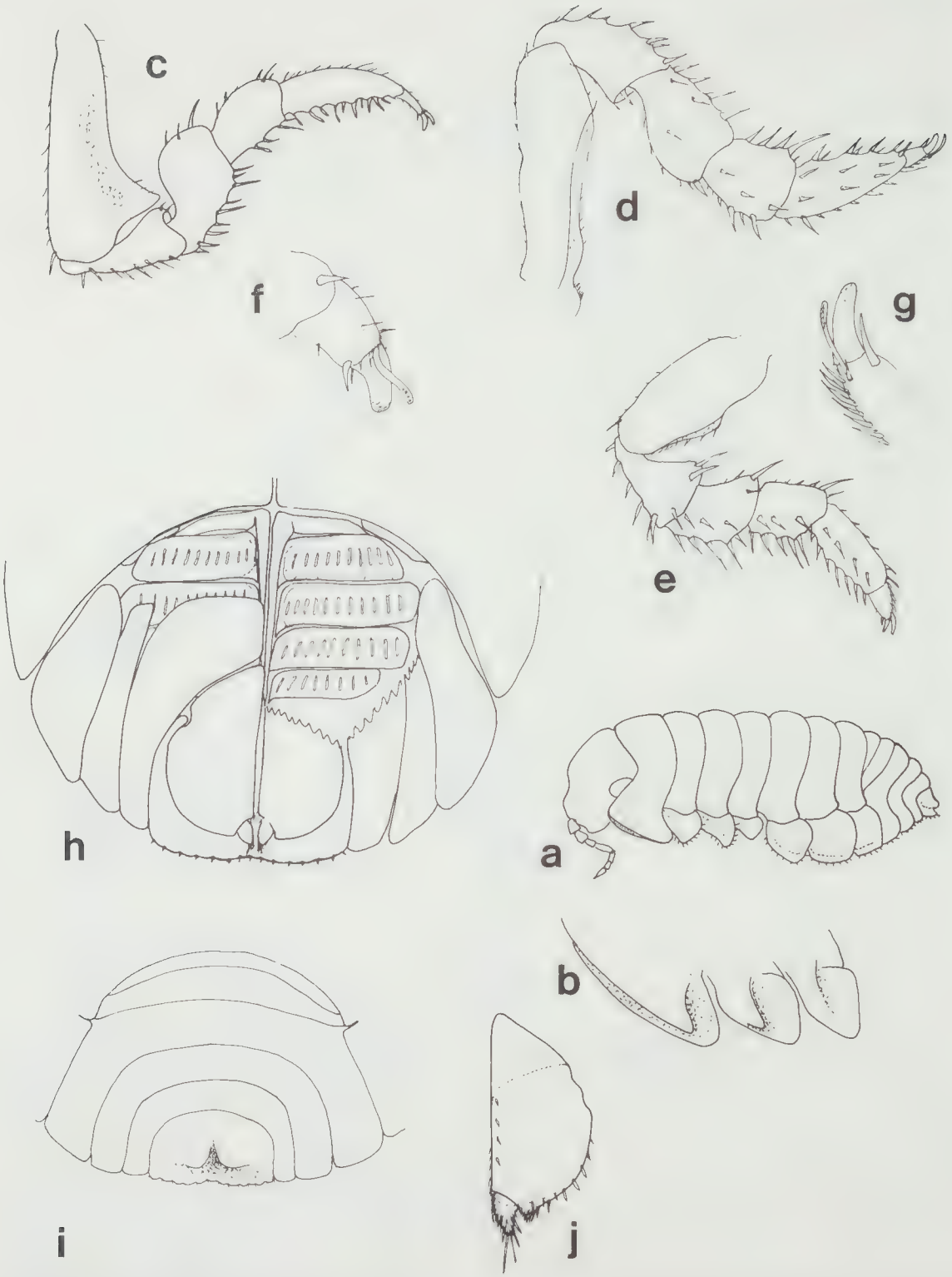

Figure 3. *Tylos bilobus* (holotype): a, lateral view of whole animal. b, ventral view of epimera 1 and 2. c, pereopod 1. d, pereopod 2. e, pereopod 7. f, dactylus of pereopod 1. g, dactylus of pereopod 7. h, ventral view of pleon. i, dorsal view of pleon. j, left uropod, ventral view.

one minute with few spines, ending with clump of setae; fifth peduncular and first 3 flagellar articles heavily spinose.

Mouthparts from male paratype of similar size. Left mandible incisor process with 2 teeth; lacinia mobilis terminating in 3 teeth with 1 penicil, bunch of setae on lobe at base; clearly separated is second small lobe with 3 penicils; molar process large, oval and flat, with penicil on medial side. Right mandible incisor process with 3 teeth; lacinia mobilis, ring of small teeth and 1 penicil; second lobe separated with 5 penicils; molar process similar to left. Labium bilobed and setose. Maxilla 1 outer lobe longer, with 4 large and 1 short, stout terminal teeth on lateral side, 5 serrated teeth medially, at bases of which are 3 short teeth; inner lobe terminating in 3 long setose penicils. Maxilla 2 broad lamella, terminally setose. Maxilliped basis with broad endopod and smaller endite; anterior edge of endopod divided into 3 lobes bearing numerous blunt setae; endite terminating in 5 setose penicils, with 1 tooth at bases of second and fourth penicils.

Pereon. Granulated and sparsely scattered with fine setae. All epimera except 1 separated. Epimeron 1 extends anteriorly closely below the eye, lateral border is smoothly curved with anterior extension of ventral lobe visible below it forming shallow, cleft border produced posteroventrally into raised, approximately triangular lobe joining anteriorly into cleft border. Ventral surface of epimeron 2 has slightly raised, subrectangular area; epimeron 3 has slightly raised ridge. Epimera 2–4 small, subtriangular; epimera 5–7 larger and subrectangular. Pereopods bases of pereopods 1–3 subequal in length to ischium, merus and carpus combined, decreasing in length on pereopod 4. Anterior margin of basis distally produced sharply to triangular process; process decreases sharply in size, small on pereopod 2 and absent on pereopods 5-7. Sulcus near the process which receives the folded limb, decreases in size from pereopod 2–4. Anterior margins of ischium and merus expanded distally into lobes. Carpus short and rounded. Dactylus short and stout on all pereopods, long dactylar organ present on all. Setae present on all articles and large, strong spines more numerous on distal 5.

Pleon. Pleonites 1 and 2 visible dorsally, 3–5 curve posteriorly to blunt points forming continuous line with pleotelson which is roughly rectangular and broader than long, with posterior margin slightly concave in midline and with regularly spaced short spines. Two large lobes on dorsal surface angled towards and close to midline. Ventrally much of pleon covered by broad plates of pleonites 3–5, those of 5 meeting medially in a straight line with anterior margins curving from midline to lateral angle.

Pleopod 1 reduced to a slender lamella curving around the lateral angle of second pleopod. Pleopod 2 endopod copulatory stylet extending past anterior margin of uropod; pseudotracheae present in exopod. Pleopod 3 exopod and endopod lamellar, folds of exopod enclosing slit openings of pseudotracheae. Pleopods 4 and 5 similar to 3.

Uropod not visible dorsally, ventral to pleotelson, wedge-shaped and plate-like, produced into a small, spinose lobe lateral to heavily setose endopod which has long spine extending from posterior angle.

Female. Length of largest specimen, 9 mm, breadth 4 mm.

Acknowledgments

I wish to thank Dr N.N. Tait, Dr D.A. Briscoe and Mr L. Bishop who read and commented on this paper.

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TWO NEW SPECIES OF ISOPOD CRUSTACEANS BELONGING TO AUSTRALIAN ENDEMIC GENERA (SEROLIDAE AND CHAETILIIDAE)

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Abstract

Poore, G.C.B., 1990. Two new species of isopod crustaceans belong to Australian endemic genera (Serolidae and Chaetiliidae). *Memoirs of the Museum of Victoria* 51: 99–107.

Basserolis franklinae sp. nov. (Serolidae) from the south-eastern Australian shelf edge and *Stegidotea latipoda* sp. nov. (Chaetiliidae) from the North-west shelf are described, being respectively the second and third species described in genera known only in Australia.

Introduction

Among Australia's endemic genera of Crustacea two genera of Isopoda have been until now known by only one (Serolidae, *Basserolis* Poore, 1985a) and two species (Chaetiliidae, *Stegidotea* Poore, 1985b). In this short contribution an additional species is described for each genus. One comes from the edge of the continental shelf in south-eastern Australia and the other from the North-west shelf.

Material is in the Museum of Victoria, Melbourne (NMV) and Australian Museum, Sydney (AM).

Serolidae Dana

Basserolis franklinae sp. nov.

Figures 1–2

Material examined. Holotype, male, 1.7 mm. Victoria, south of Point Hicks (38°14.80′S, 149°9.30′E), 200 m, coarse sand and gravel, WHOI epibenthic sled, M.F. Gomon et al. on RV Franklin, 24 Jul 1986 (stn SLOPE 41), NMV J17642 (with 3 slides).

Paratypes. Type locality, NMV J17643 (1 male, 4 slides), J17644 (10 specimens), AM P40047 (4 specimens).

Diagnosis. Male. Body outline roughly pyriform, about 1.2 times as long as wide, widest at pereonite 1 and tapering to about two-thirds maximum width at pleotelson. Head as long as pereonite 1, together one-third total length. All margins of pereonites, pleon, antennal peduncles and uropods finely serrate. Sutures between the dorsal coxal plates and tergites of pereonites 2–6 weekly visible; coxae 2–6 obliquely truncate. Pleotelson 1.7 times as wide as long, posteriorly broadly rounded, with 2 minute denticles at apex.

Antennae 1 and 2 of very similar proportions, setation and aesthestasc arrangement as *B. kimblae*. Mouthparts identical to those of *B. kimblae* except mandibular palp article 3 with 4 apical setae (3 in *B. kimblae*).

Pereopod 1 with same proportions and setation as *B. kimblae* but palmar spines longer and end of dactylus curved (straight in *B. kimblae*). Pereopods 2–7 and pleopods 1–5 with same proportions and setation as in *B. kimblae*.

Uropodal peduncle with subacute medial projection, lateral margina and apex of medial margin serrate; endopod exceeding peduncle, twice as long as wide, tapering to serrate apex; exopod about ahalf length of endopod.

Female. Unknown.

Etymology. Like *B. kimblae* this species is named for the vessel from which it was collected, in this case ORV "Franklin".

Distribution. South-eastern Australian shelf edge, 200 m (type locality only).

Remarks. The species is very similar to *Basserolis kimblae* Poore, 1985 but is easily recognised by its characteristic tapering shape (*B. kimblae* is more oval, has a proportionly larger pereonite 1 and lacks the marginal serration). The new species also differs in the form of pereopod 1 and the uropod. The uropodal endopod of *B. franklinae* is longer and narrower than in *B. kimblae*.

The new species confirms the generic diagnosis of *Basserolis*. Detailed similarities between the two species extend to setation of the mouthparts, antennae and pereopods. Closer examination of both species has shown that weak coxal sutures are visible on pereonites 2–6 in speci-

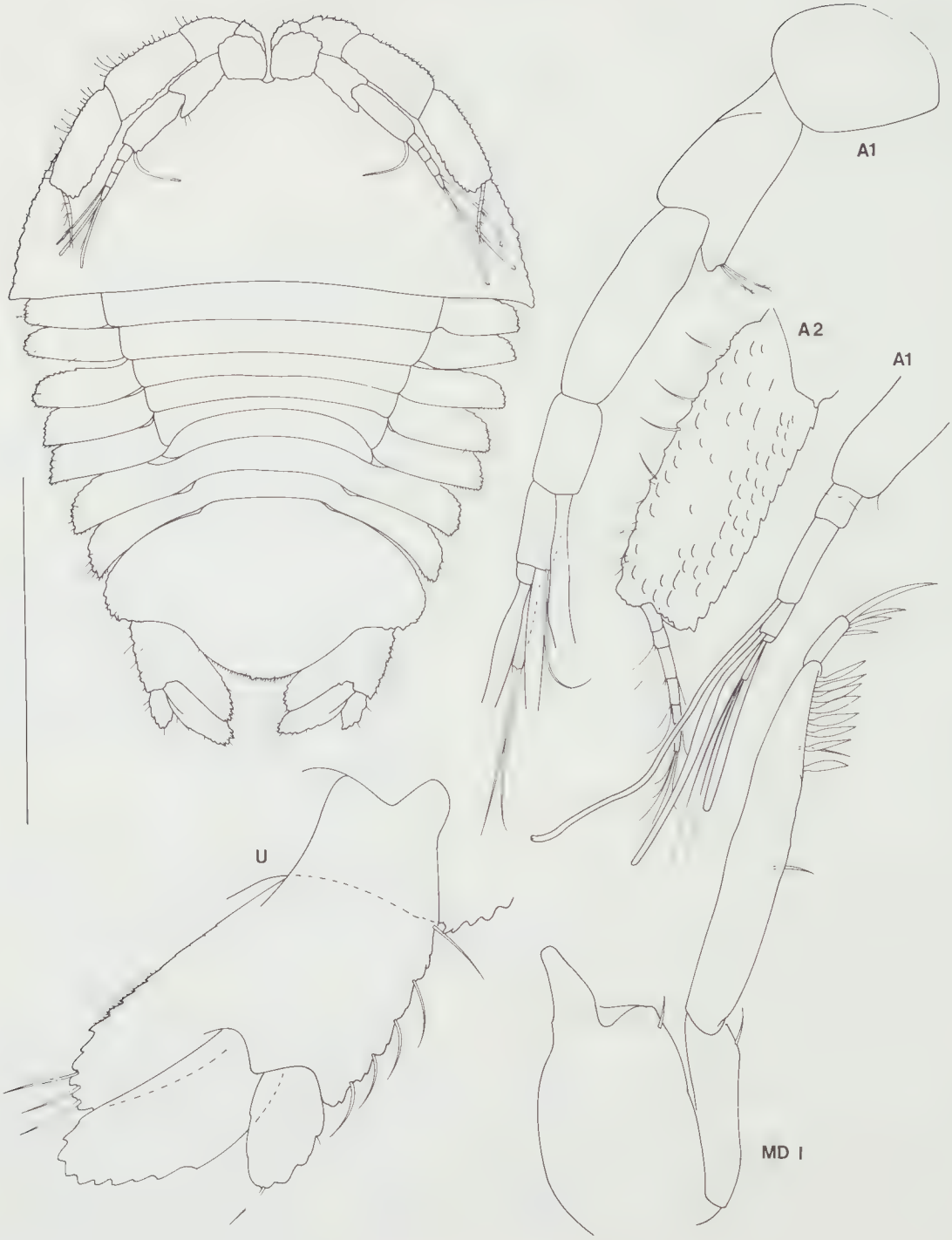

Figure 1. *Basserolis franklinae*, holotype. A1, A2, antenna 1 and 2; MDI, left mandible; U, left uropod, ventral; scale line = 1 mm.

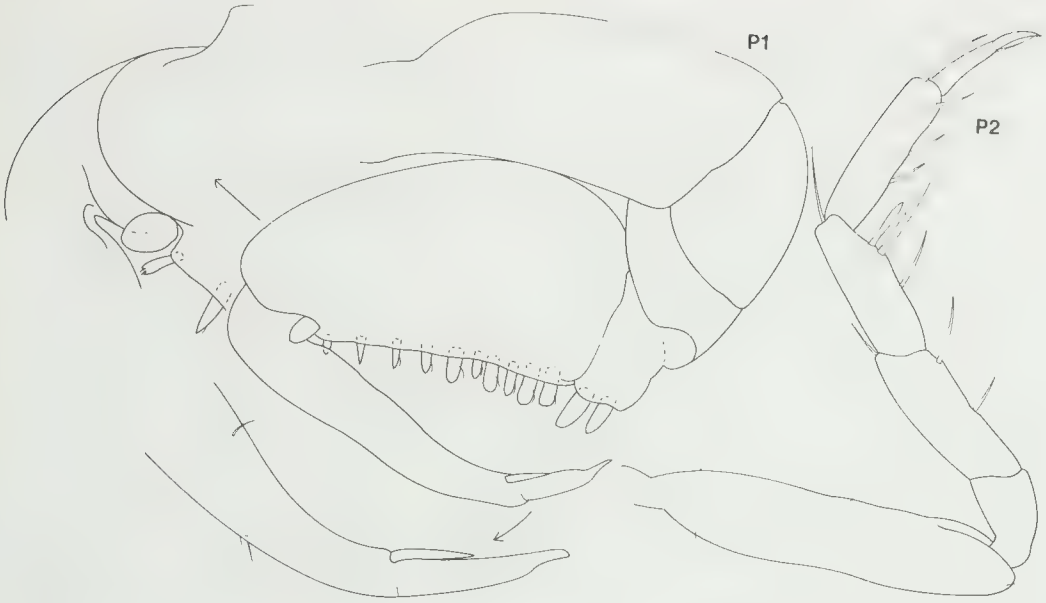

Figure 2. *Basserolis franklinae*, holotype. P1, P2, pereopod 1 and 2.

mens of both species, not only on pereonites 2–4 as shown for *B. kimblae*. This visibility of these sutures depends on preparation and lighting.

The mandible in figure 1 is shown at a different perspective from that of *B. kimblae* (Poore, 1985a: fig. 3a) but is similar in the two species. The distoventral step seen in the new figure accomodates the upper lip which protects the incisor (see Poore, 1985a: fig. 1a).

Both species are notable for the possession of a discoid seta mesio-distally on the palm of pereopod 1 and fitting into the base of the dactyl.

The new species was taken from a single station at 38°S at 200 metres depth during sampling programs which sampled more than 200 benthic stations between 37°S and 41°S and 16 m and 3150 m.

Basserolis kimblae Poore

Remarks. Recently collected material of *B. kimblae* extends its depth and latidudinal range beyond that known when it was described. It is now known from 3 specimens from c. 37°S at 520 m off New South Wales and 17 specimens from c. 40°S at 120 m off eastern Bass Strait. The only known occurrence of *B. franklinae* lies between these extremes.

Chaetiliidae Dana

Stegidotea Poore, 1985

Remarks. Only two genera of Chaetiliidae possess an antenna 2 with a flagellum composed of a major plus two minor articles, *Stegidotea* (with two species) and *Symmius* Richardson, 1904 (also with two species) (Poore, 1984, 1985b). The new species described here does not agree exactly with the current diagnoses of either.

Symmius is distinguished from *Stegidotea* by the possession of two elongate uropodal rami (short and unequal in *Stegidotea*), stongly lobed maxillipedal palp articles 4 and 5 (not lobed), and in pereopod 7 lacking an unguis (unguis well developed). The new species has none of these features characterising *Symmius* and is more similar to *Stegidotea* in general habitus, arrangement of dorsal sculpture, pereopods and uropods.

Differences between this species and the two previously known require restatement of three character states used by me to define *Stegidotea*:

1. Pleonites 1 and 2 are completely delimited dorsally, pleonite 3 completely or partially so.

2. Mandibular molar process is an untoothed boss or fully toothed and setose.

3. Maxillipedal palp with article 2 and 3 fused or free.

Key to Australian species of *Stegidotea*

1. Bases of pereopods 5–7 about half as wide as long and overlapping; dorsal scupture obscure; antennae 1 and 2 of similar lengths . *S. latipoda*
— Bases of pereopods 5–7 linear and not overlapping; dorsally 3 rows of carinae; antenna 1 shorter than antenna 2 2
2. Pereon with mid-dorsal and midlateral rows of strong triangular carinae; pleonite 4 wider than remaining pleotelson; head only partly immersed in pereonite 1 ..... *S. pinnata*
— Pereon with mid-dorsal and midlateral rows of weak carinae; pleonite 4 as wide as remaining pleotelson; head immersed between wider shoulders of pereonite 1 ..... *S. scabra*

Stegidotea latipoda sp. nov.

Figures 3–6

Material examined. Holotype, female, 4.7 mm. Western Australia, North-west Shelf,between Dampier and Port Hedland (19°8.4′S, 119°2.4′E), 78 m, WHOI epibenthic sled, CSIRO, Division of Fisheries on RV Socla, 11 Dec 1982 (stn NWA 349), NMV J17664 (with 2 slides).

Description. Body almost 3 times as long as wide, dorsoventrally moderately convex; uropods dominate lateral view posteriorly. Integument with clear pattern of regular small pits all over. Head with a sinuous anterior margin; lateral margin of head rounded. Pereonites with obscure mid-dorsal ridge posteriorly, with obscure midlateral and lateral crests, more prominent posteriorly; pleon with only obscure dorsal bosses. Dorsal coxal plates rounded posteriorly. Pleon almost half total length; pleonite 1 short, narrower than pleonites 2 and 3, free; pleonites 2 and 3 free but not articulating, not laterally expanded; pleotelson tapering to sharply rounded apex.

Antenna 1 reaching to near lateral margin of head, about as long as antenna 2; articles of peduncle subequal in length; flagellum as long as last article of peduncle, its article 2 minute; flagellar articles with short apical aesthetascs. Antenna 2 peduncle article 3 with 1 strong distolateral seta, article 5 with 7 strong lateral setae; flagellum shorter and narrower than last article of peduncle, of 3 articles of decreasing lengths.

Mandible with toothed incisor; lacinia mobilis weakly developed, broader on left than on right; spine row of 2–3 short spines fused to lacinia mobilis; molar simple, untoothed. Maxilla 1 with 2 setae on inner lobe, 10 uneven finely denticulate setae on outer lobe. Maxilla 2 with mesial plumose seta and 5 denticulate setae apically; middle and outer lobes with 9 and 8 falcate setae on oblique apices. Maxillipedal endite reaching two-thirds along fused articles 2 and 3 of palp, without coupling hooks, with 2 apical setae separated by a distal tooth plus 3 setae in oblique posterior row; palp ovate, articles 2 and 3 fused with mesial setae only, article 5 short.

Pereopods 1–3 similar in form and size. Pereopod 1 carpus posteriorly lobed with 2 posterodistal short setae; propodus with 2 proximal setae on palm; dactylus closes on carpus. Pereopods 2 and 3 similar, bases slightly wider than on percopod 1. Pereopods 4–7 ambulatory; basis of 4 about 4 times as long as wide, of 7 about 2.5 times as long as wide; ischium with posterior lobe overlapping basis when closed; carpus with 1 and propodus with 2 posterior strong setae.

Pleopod 1 with almost square peduncle; rami shorter than peduncle, overlapping; endopod with 7 long distal apical plumose setae; exopod broader, with 16 apical and lateral plumose setae plus 1 simple seta at mediodistal corner. Pleopod 2 peduncle wider than long; rami similar to those of pleopod except simple exopodal seta absent. Pleopod 3 similar to pleopod 2 except exopod 2-articulate. Pleopods 4 and 5 similar; exopod 2-articulate, each article with 1 or 2 simple short setae.

Uropodal peduncles interlocking with a catch anteriorly, with row of obscure rugae, and with mesiodistal plumose seta; endopod triangular, apically rounded; exopod narrow, parallel-sided, with 5 plumose setae on oblique terminal margin.

Colour in alcohol white.

Figure 3. *Stegidotea latipoda*, holotype. Scale line = 1 mm.

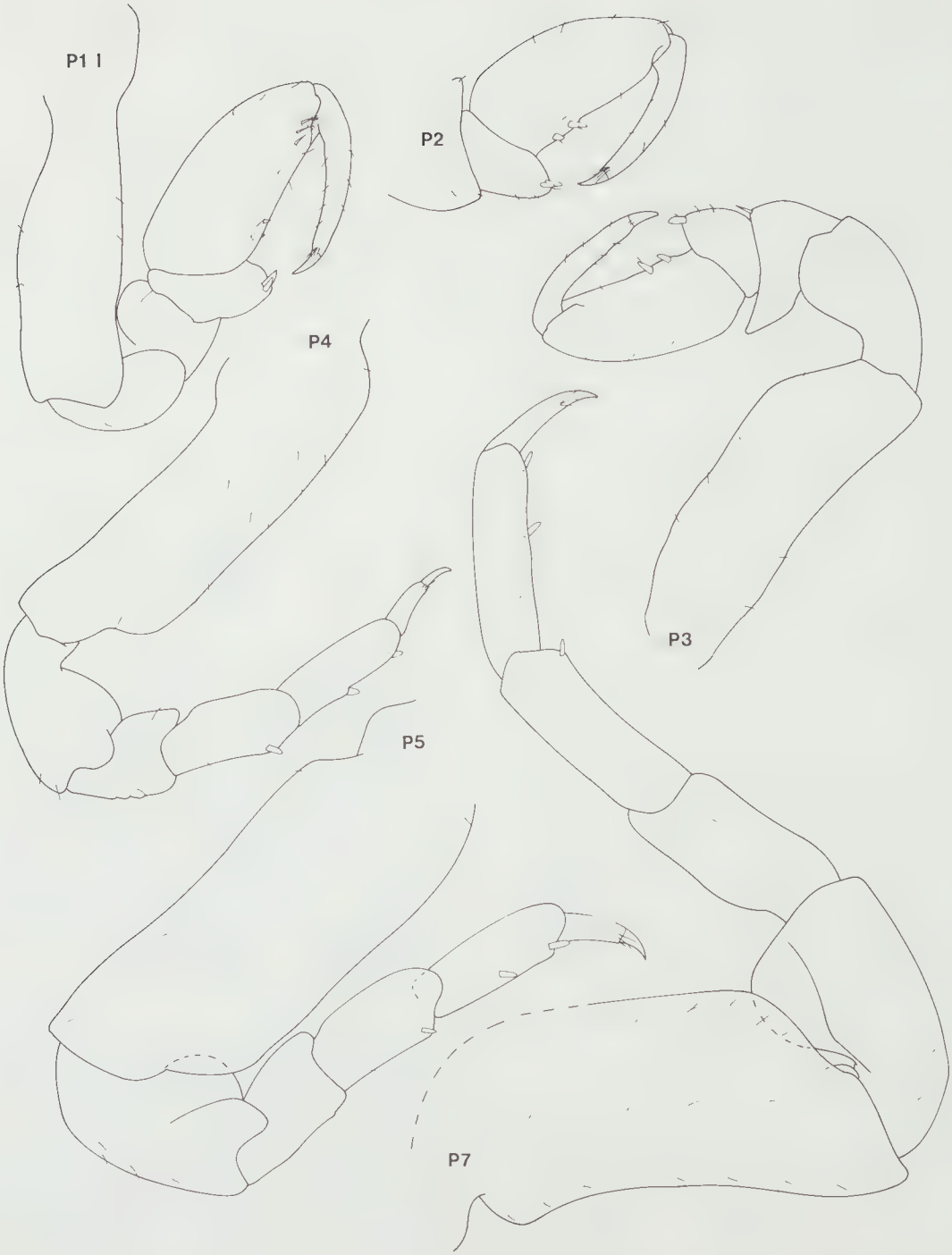

Figure 4. *Stegidotea latipoda*, holotype. P1, P2, P3, P4, P5, P7. pereopods 1, 2 (part), 3, 4, 5, 7.

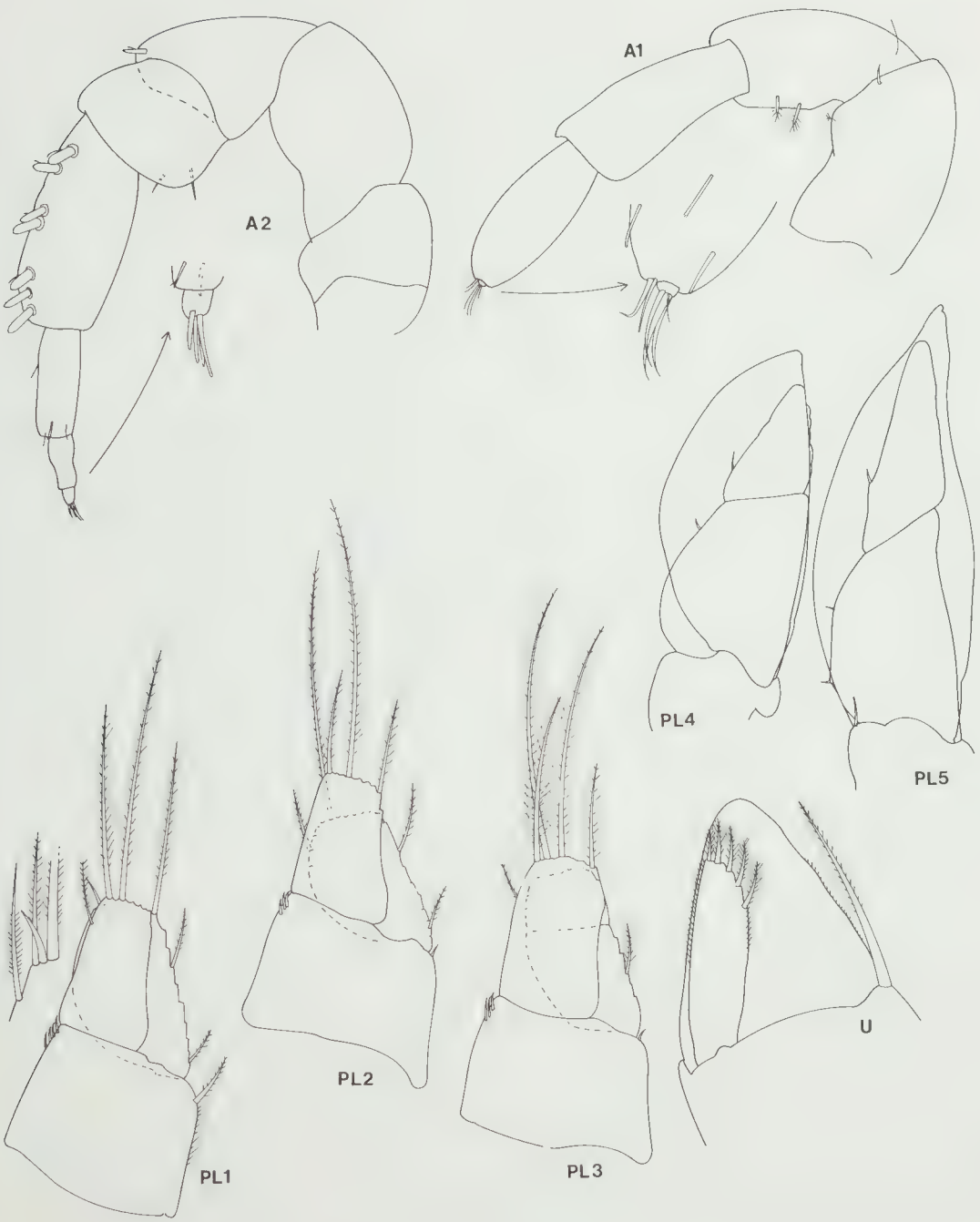

Figure 5. *Stegidotea latipoda*, holotype. A1, A2, antennae 1 and 2; PL1–PL5, pleopods 1–5; U, uropodal rami.

Figure 6. *Neaxius vicinus lampensis* holotype. MD1, MD2, left and right mandibles with detail; MX1, maxilla 1; MX2, maxilla 2 with lobes in detail; MP, maxilliped; MPe, maxillipedal endite, anterior.

Etymology. The specific name alludes to the broad bases of the posterior pereopods.

Distribution. North-western Australian shelf, 78 m. (type locality only).

Remarks. There are several differences between this species and the two others previously known. In *S. latipoda* pleonite 1 is only slightly narrower than the rest and pleonites 1–3 are completely delimited dorsally from each other and from the pleotelson. In *S. pinnata* Poore and *S. scabra* Poore pleonite 1 is free but not visible laterally, pleonite 2 is completely free, and pleonites 3 and 4 are free only laterally.

The molar of *S. latipoda* is an untoothed boss (it is fully toothed and setose in the other two species; the difference is not sex-dependant). Articles 2 and 3 of the maxillipedal palp are fused (separated by a suture in the original species) and the maxillipedal endite lacks a coupling hook (present in *S. pinnata* and *S. scabra*). In general shape the mouthparts of all three species are similar.

Pleopod 1 of *S. latipoda* is very different. The two rami are simple, broad and overlap. In *S. pinnata* and *S.scabra* the rami are narrow and do not overlap and the exopod bears "stridulatory" ridges.

As well as these characters and its general habitus the species is notable for the extreme width of the bases of pereopods 5–7 which overlap anterior to the uropodal cavity as if to extend it forward to the middle of the pereon.

Stegidotea latipoda is known from a single specimen from a midshelf depth on the North-west shelf of Australia. Its congener, *S. pinnata*, occurs at shallower depth, 42 m, on the same shelf but is more common in Bass Strait and the south-eastern Australian shelf between 47 and 204 m. *S. scabra* has been found only in Bass Strait at 55–95 m.

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Note added in press: In a paper in preparation for *Mémoires du Muséum National d'Histoire Naturelle, Paris*, three additional species of *Stegidotea* from deeper waters near New Caledonia are described.

Memoirs of the Museum of Victoria 51: 109–119 (1990) ISSN 0814-1827

CHELANTHURA (CRUSTACEA: ISOPODA: ANTHURIDAE), A NEW GENUS FROM SOUTHERN AUSTRALIA

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Abstract

Poore, G.C.B. and Bardsley, T.M., 1990. *Chelanthura* (Crustacea: Isopoda: Anthuridae), a new genus from southern Australia. *Memoirs of the Museum of Victoria* 51: 109–119.

Chelanthura, a new genus of anthurid isopod is erected for *C. ajuga* sp. nov. (type species), *C. salvia* sp. nov., *C. westringia* sp. nov. and *Mesanthura calaena* Poore and Lew Ton. The genus differs from *Mesanthura* in the possession of a chelate first pereopod.

Introduction

Discovery of three new species similar to *Mesanthura calaena* (Poore and Lew Ton, 1986) prompted a reappraisal of their generic placement. The four are sufficiently distinctive to warrant a new genus.

The following abbreviations are used in figures 2-9: A1, A2, antennae 1 and 2; MD, mandible; MP, maxilliped; P1-P7, pereopods 1-7; PL1-PL5, pleopods 1-5; UN and UX, uropodal endopod and exopod; T, telson; l, left; r, right. Material is lodged in the Museum of Victoria, Melbourne (NMV), the Queensland Museum, Brisbane (QM), the Australian Museum, Sydney (AM) and the Western Australian Museum, Perth (WAM).

Chelanthura gen. nov.

Diagnosis. Integument pigmented. Eyes present. Antenna 1 flagellum of 3 articles, the last with 3 terminal aesthetascs. Antenna 2 flagellum short and composed of few short articles. Mandibles symmetrical; incisor, lamina dentata and molar process present; palp of 3 articles, article 3 shorter than 2 with row of few marginal setae. Maxillipedal endite absent; palp articles 1 and 2 fused, 2 and 3 weakly differentiated if at all, 3 and 4 clearly delimited, and 4 and 5 fused and with 4 mesially-directed setae.

Pereopod 1 chelate; carpus and propodus fused, propodus enlarged and elongate, its palm extremely produced and bearing complex grinding surface. Dactylus broad, almost rectangular with a complexly ridged surface on the flattened distal margin opposing the produced palmar surface; unguis subterminal. Pereopods 2 and 3 slightly more robust than posterior pereopods. Pereopods 4–7 with carpus triangular, its anterior margin free.

Pleon about as long as pereonite 6. Telson tapering over posterior third, apex with 3 pairs of setae.

Etymology. From the Latin *chela*, a claw, and *Anthura*, type genus of Anthuridae.

Type species. Chelanthura ajuga sp. nov.

Remarks. Chelanthura differs from *Mesanthura* in the possession of a chelate pereopod 1 formed by a sharply produced fixed finger on the propodus and a broad dactylus with a complexly ridged distal margin. These structures have homologues in *Mesanthura*. The fixed finger is a gross extension of the palmar boss seen in some species of *Mesanthura* (e.g., *M. astelia* Poore and Lew Ton, 1986) but is more complex and forms a grinding surface opposing the end of the dactylus.

The unguis is reduced, subterminal and barely projects beyond the end of the dactylus. In all species of *Mesanthura* the unguis is terminal and projects as in all other anthurids. The denticulate boss at the base of the unguis in some species of *Mesanthura* (e.g., *M. astelia*, *M. romulea* Poore and Lew Ton, 1986) is homologous to the distal surface of the dactylus in *Chelanthura*.

In no species of *Chelanthura* were we able to define the suture between the carpus and propodus. Its most distal point could be seen and was defined by a group of setae on the posterior margin of the enlarged carpus-propodus.

Another minor difference between the two genera was seen in the lamina dentata which is

poorly toothed in *Chelanthura* and regularly toothed in all species of *Mesanthura* examined by us.

We interpret the terminal article of the palp of *Chelanthura* and *Mesanthura* as the fused articles 4 and 5 of the primitive 5-articled palp. The more proximal portion derives from three articles: the first article which is rarely differentiated in anthurideans, and articles 2 and 3 which, in *Chelanthura*, may or may not be separated by a suture. Their boundary is marked by a mesial seta. Such variability is not usual in anthurid genera where the number of articles has often been used as a generic character.

Key to species of *Chelanthura*

1. Pigment in well-defined transverse bands on head, pereonites 1–7 and pleon; mandibular palp article 3 with 7 setae ..... *C. calaena*
— Pigment in irregular patches or more or less continuous longitudinally; mandibular palp article 3 with 4 or 5 setae 2
2. Antenna 2 peduncle broad (article 5 broader than long); pereopod 1 unguis well produced beyond distal grinding surface; pigment in 2 dorsal longitudinal stripes ..... *C. westringia*
— Antenna 2 peduncle narrow (article 5 longer than broad); pereopod 1 unguis not or slightly produced beyond distal grinding surface; pigment variable 3
3. Pereopod 1 propodus robust (1.2 times as long as wide); unguis slightly overlapping distal grinding surface of dactylus; telson widest two-thirds way along; pigment diffuse patches ..... *C. salvia*
— Pereopod 1 propodus elongate-ovoid) (1.7 times as long as wide); unguis not overlapping distal grinding surface of dactylus; telson widest half way along; pigment even dorsally ..... *C. ajuga*

Chelanthura ajuga sp. nov.

Figures 1a, b, 2–4

Material examined. Holotype. Western Australia. 7 Mile Beach (29°12.0′S, 144°53.0′E), 1 m, G. Edgar, 1985, NMV J17112 (1 preparatory female, 2 slides).

Paratypes. Western Australia. 7 Mile Beach (29°12.0′S, 144°53.0′E), 1 m, *Amphibolus*, G. Edgar, 1985, NMV J16936 (1 preparatory female, 2 slides); WAM 78-90 (8 juveniles, 1 submale); NMV J16939 (2 juveniles); NMV J16940 (4 ovigerous females, 7 juveniles, 1 submale); NMV J16937 (1 juvenile).

Other material. Queensland. Heron Island, Canyons (23°27.0′S, 151°55.0′E), 3 m, N.L. Bruce, Dec 1979, QM W16564 (1 female, 2 slides); Heron Island, N.L. Bruce, 15 Jan 1979, QM W16565 (1 female).

Diagnosis. Head, pereonites and pleotelson with pigment patches over most of the dorsal surface; small lateral patches may be present on more posterior segments. Pereonites 1–3 with heart-shaped patches, pigment most dense on anterior part of segment; pereonites 4–7 and pleon with dense pigment on posterior part of segments; pereonites 6 and 7 and pleon with mid-dorsal elongate nonpigmented patches; dense pigment on uropodal exopod; pigment patches on endopod and telson.

Antenna 1 peduncle, article 3 twice as long as wide. Antenna 2 peduncle, article 4 1.5 times as wide as long. Mandible with ridged lamina dentata; palp article 3 with 4 marginal seta. Maxillipedal palp with articles 2 and 3 fused.

Pereopod 1 propodus elongate-ovoid, about 1.7 times as long as wide. Pereopod 1 fixed finger about one-seventh as long as posterior length of fused carpus and propodus, its grinding surface axial; dactylus inner margin without distal teeth; unguis narrow, about two-thirds as long as distal margin of dactylus and reaching apex of dactylus.

Pleonite 6 with triangular medial notch on posterior margin. Uropodal endopod almost as wide as long. Telson moderately acutely tapered, widest halfway along its length.

Description. Integument dorsally pigmented (see *Diagnosis*).

Antenna 1 peduncle article 1 square, with brush setae; article 2 wider than long with 1 simple seta and 2 brush setae; article 3 twice as long as wide with tooth on the mesial margin and 3 simple setae; flagellum article 1 short with brush setae, article 2 twice as long as wide, article

3 short with 3 terminal aesthetascs and setae. Antenna 2 peduncle articles 2–4 at least as long as wide with setae; article 5 with simple setae and 2 brush setae; flagellum of 4 very short articles with many mesial setae.

Mandible of molar process with triangular tooth, ridged lamina dentata and blunt incisor. Mandibular palp of 3 articles, much longer than incisor; article 1 with 1 distal seta, article 3 short with row of 4 setae. Maxillipedal palp with articles 1, 2 and 3 fused, together longer than wide and with a blunt mesiodistal process, with 1 mesial and 2 mesiodistal setae plus fine hairs; terminal article with 1 mesial plumose seta and 4 strong terminal setae.

Pereopod 1 chelate; carpus and propodus fused, propodus elongate-ovoid, its palm much produced to form an axial elongate fixed finger with a ridged surface and marginal setae. Dactylus broad and bearing a regular row of teeth on

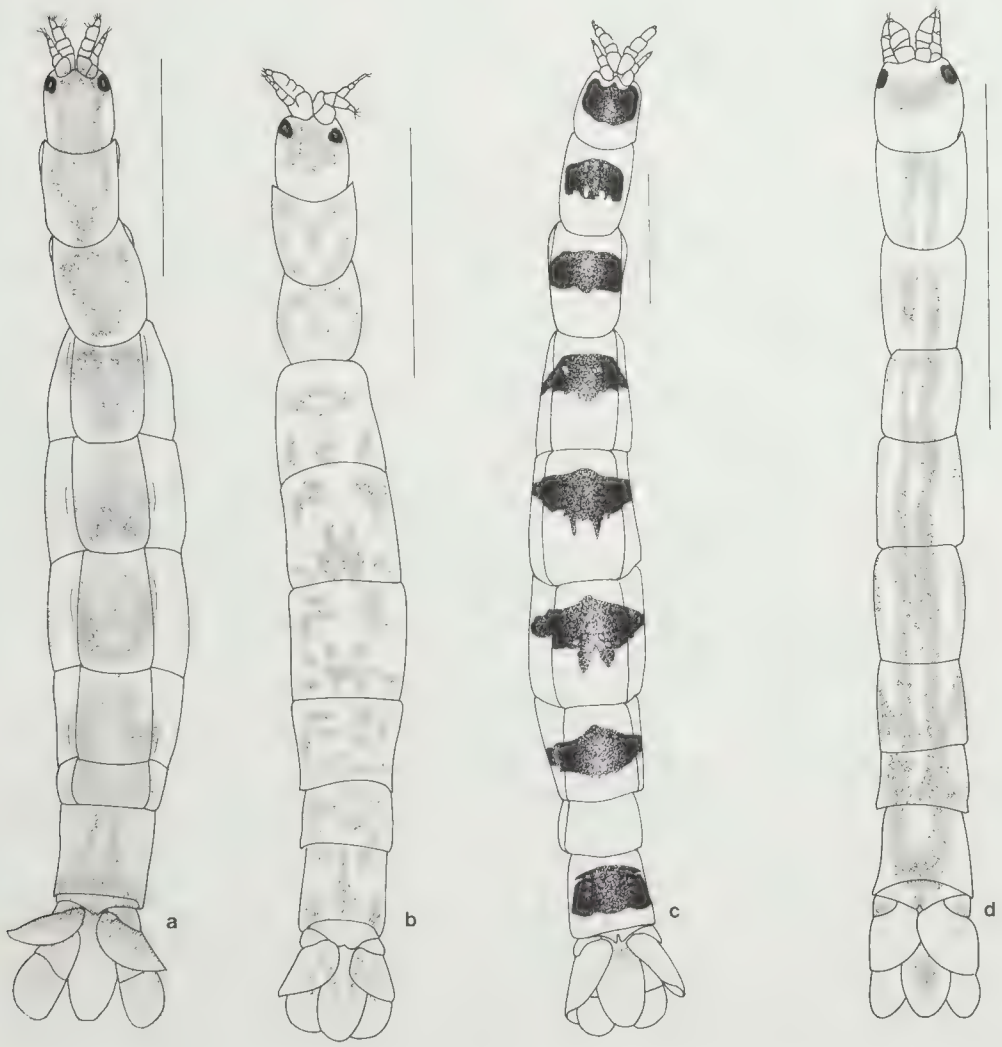

Figure 1. a, *Chelanthura ajuga*, holotype female, 4.5 mm, J17112; b, *Chelanthura salvia*, holotype female, 3.7 mm, J16795; c, *Chelanthura calaena*, holotype juvenile, 6.7 mm, J4452 (from Poore and Lew Ton, 1986); d, *Chelanthura westringia*, holotype juvenile, 2.7 mm, J16941. (scale bars = 1 mm)

Figure 2. *Chelanthura ajuga*, holotype. Pereopod 1 with mesial and lateral detail of palm and dactylus; pereopods 2, 4 and 7.

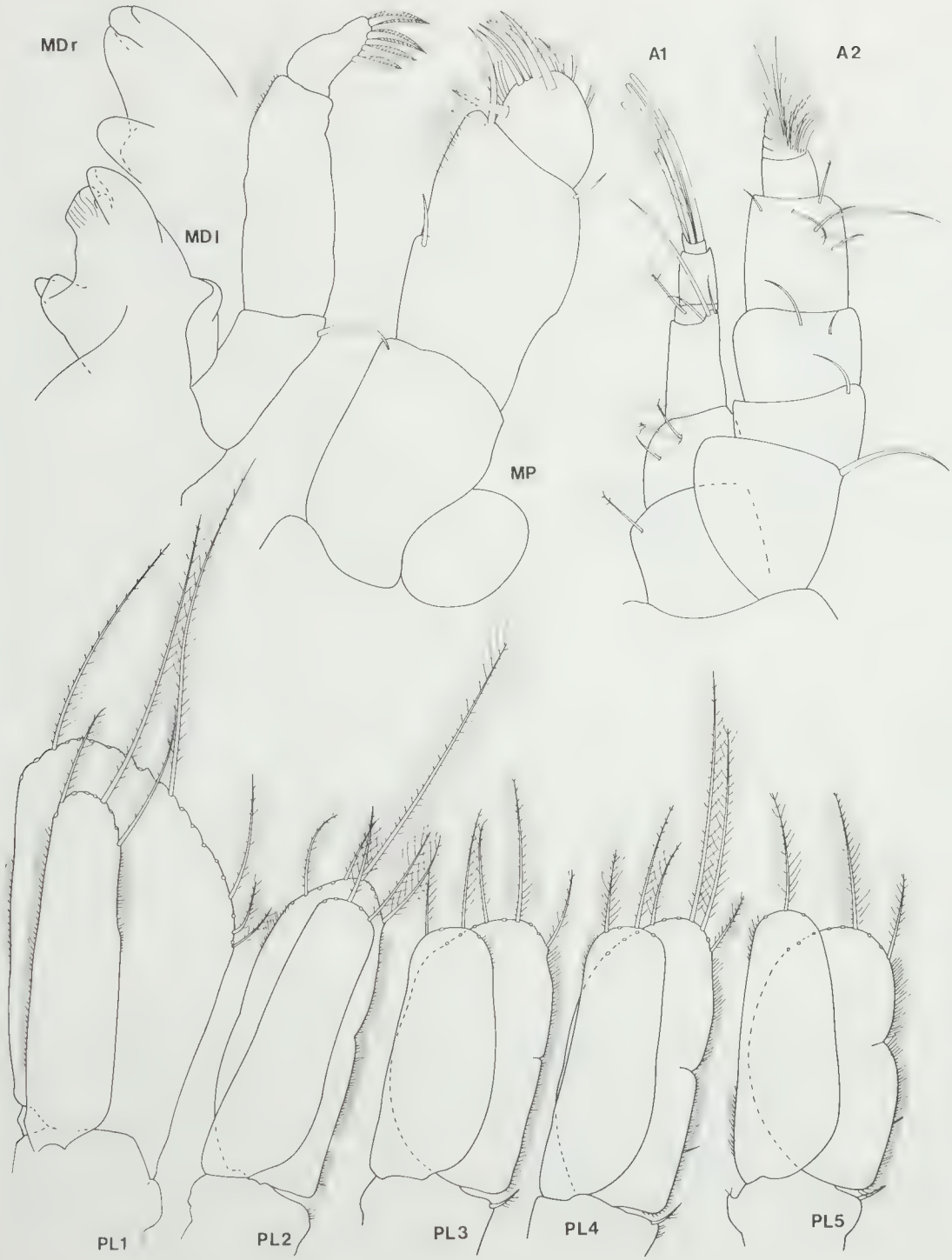

Figure 3. *Chelanthura ajuga*, holotype. Antennae, left mandible, maxilliped, pleopods 1–5.

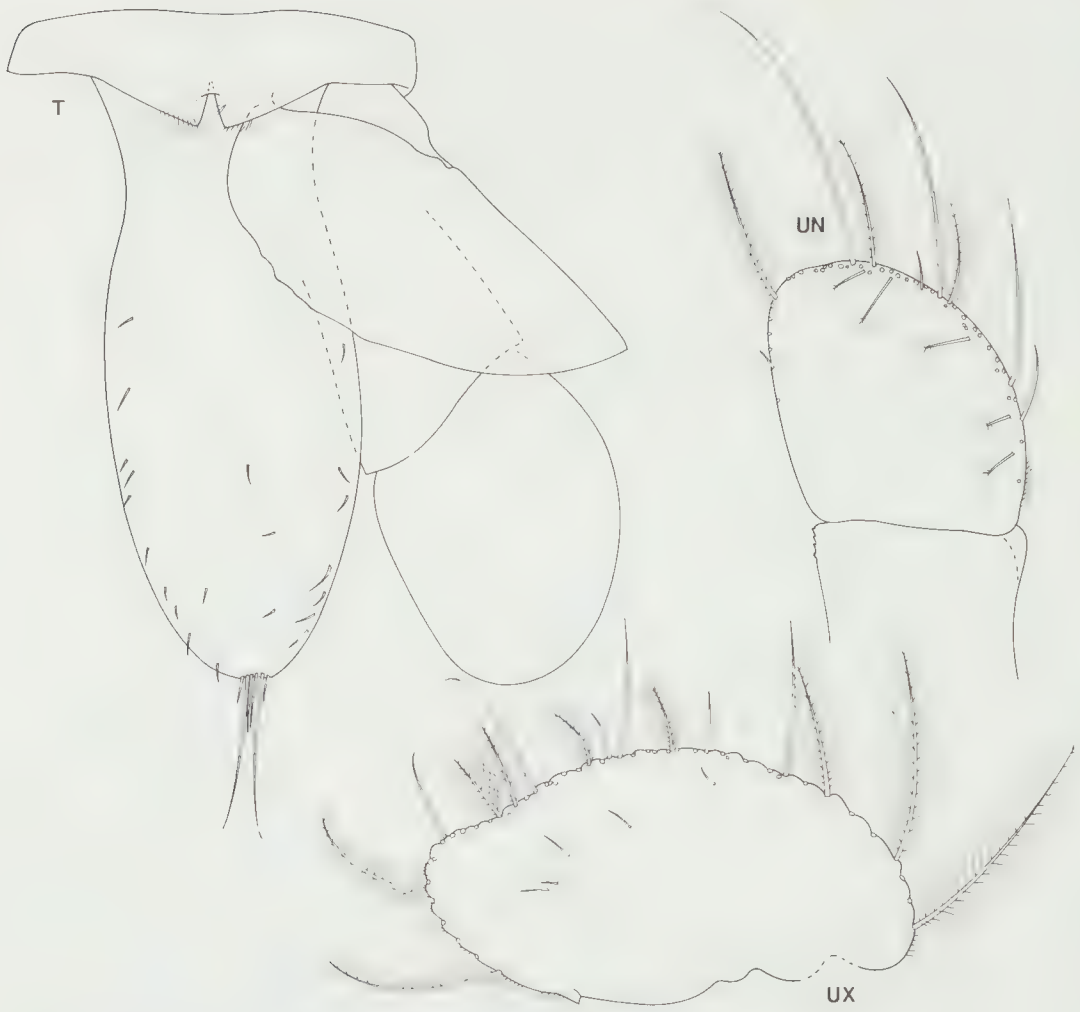

Figure 4. *Chelanthura ajuga*, holotype. Pleotelson, uropodal endopod and exopod.

the distal margin with unguis arising mid-laterally; unguis about two-thirds length of distal margin (see *Diagnosis*).

Pereopods 2 and 3 propodus 2.2 times as long as wide, palm bearing strong posterodistal seta; dactylus about half as long as propodus; terminal primary and small secondary unguis present. Pereopod 4 carpus with short anterior margin, its distal margin with strong seta; propodus 2.4 times as long as wide with distal strong seta; dactylus curved. Pereopods 5–7 similar to pereopod 4, becoming more elongate posteriorly.

Pleon about as long as pereonite 6. Pleonite 6 with triangular notch on posterior margin. Pleopod 1 exopod operculiform, distal margin setose; endopod subequal in length and about one-third as wide as exopod, distally setose. Pleopod 2 elongate, rami subequal, setose. Pleopods 3–5 rami shorter than 2, subequal setose.

Uropodal endopod almost as wide as long, bearing dense marginal row of long simple setae with few plumose setae; 5 brush setae submarginally on dorsal surface. Exopod almost twice as long as wide with a dense marginal row of mostly plumose setae with few long simple setae. Telson about 2.5 times as long as wide, greatest width about one-third along, tapering moderately acutely to a rounded apex with concave tip bearing 3

pairs of setae: short plumose near midpoint, long simple setae next, and short simple setae laterally.

Etymology. Ajuga is a genus of Australian native flowering plant.

Distribution. Western Australia and Queensland; intertidal to 3 m.

Remarks. Chelanthura ajuga is very similar to *C. salvia*, especially in proportions of the antennae, pereopods, uropods and telson. It differs in pigmentation and in the shape of pereopod 1. *Chelanthura ajuga* shares with *C. westringia* a maxillipedal palp with articles 2 and 3 fused. These two articles are separate in *C. calaena* and all species of *Mesanthura*) and are partially separate in *C. salvia.*

We were able to discern the remnant of the lacinia mobilis on the left mandible of this species and *C. salvia.* This has been noted before for Anthuridea only in Hyssuridae (Poore and Lew Ton, 1988: fig. 7).

Chelanthura calaena (Poore and Lew Ton)

Figures 1c, 5

Mesanthura calaena Poore and Lew Ton, 1986: 96, 97, figs 2b, 7.

Material examined. Type material, see Poore and Lew Ton (1986).

Diagnosis. Head, pereonites 1–6 and pleon with transverse bands of pigment occupying about middle third of each segment. Pigment patches with few clear areas, their anterior margins fairly even, but posterior margins bilobed on pereonites 4 and 5. Pigment extending laterally especially on pereonites 1–3.

Antenna 1 peduncle, article 3 twice as long as wide. Antenna 2 peduncle with fine mesial setae, article 4 1.3 times as long as wide. Mandible with lamina dentata of 4 teeth; palp article 3 with 7 setae. Maxillipedal palp with articles 2 and 3 weakly defined.

Pereopod 1 fixed finger about one-fifth as long as the posterior length of the fused carpus and

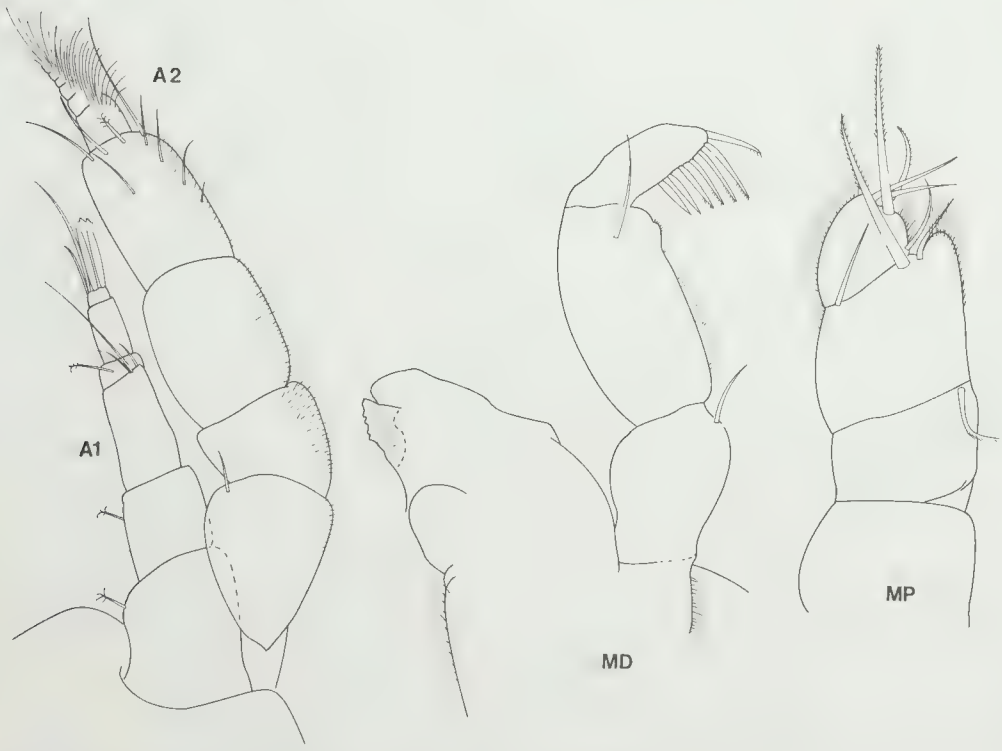

Figure 5. *Chelanthura calaena*, holotype. Antennae, left mandible and maxilliped.

propodus; its grinding surface axial. Dactylus inner margin with teeth; unguis attached laterally, about half as long as distal surface of dactylus but not overlapping it.

Pleonite 6 with narrow, elongate medial notch on posterior margin. Uropodal endopod wider than long. Telson moderately tapered.

Distribution. Victoria and South Australia, intertidal and subtidal.

Remarks. In the original description a suture between the carpus and propodus of pereopod 1 was illustrated. Re-examination failed to find it. The species is easily recognisable from its well-defined colour pattern. We illustrate antennae, mandible and maxilliped for comparison with other species.

Chelanthura salvia sp. nov.

Figures 1b, 6, 7

Material examined. Holotype. New South Wales. Coffs Harbour (30°18.0′S, 153°09.0′E), 5 m, S. Smith, 11 Jul 1989, NMV J16795 (1 preparatory female, 2 slides).

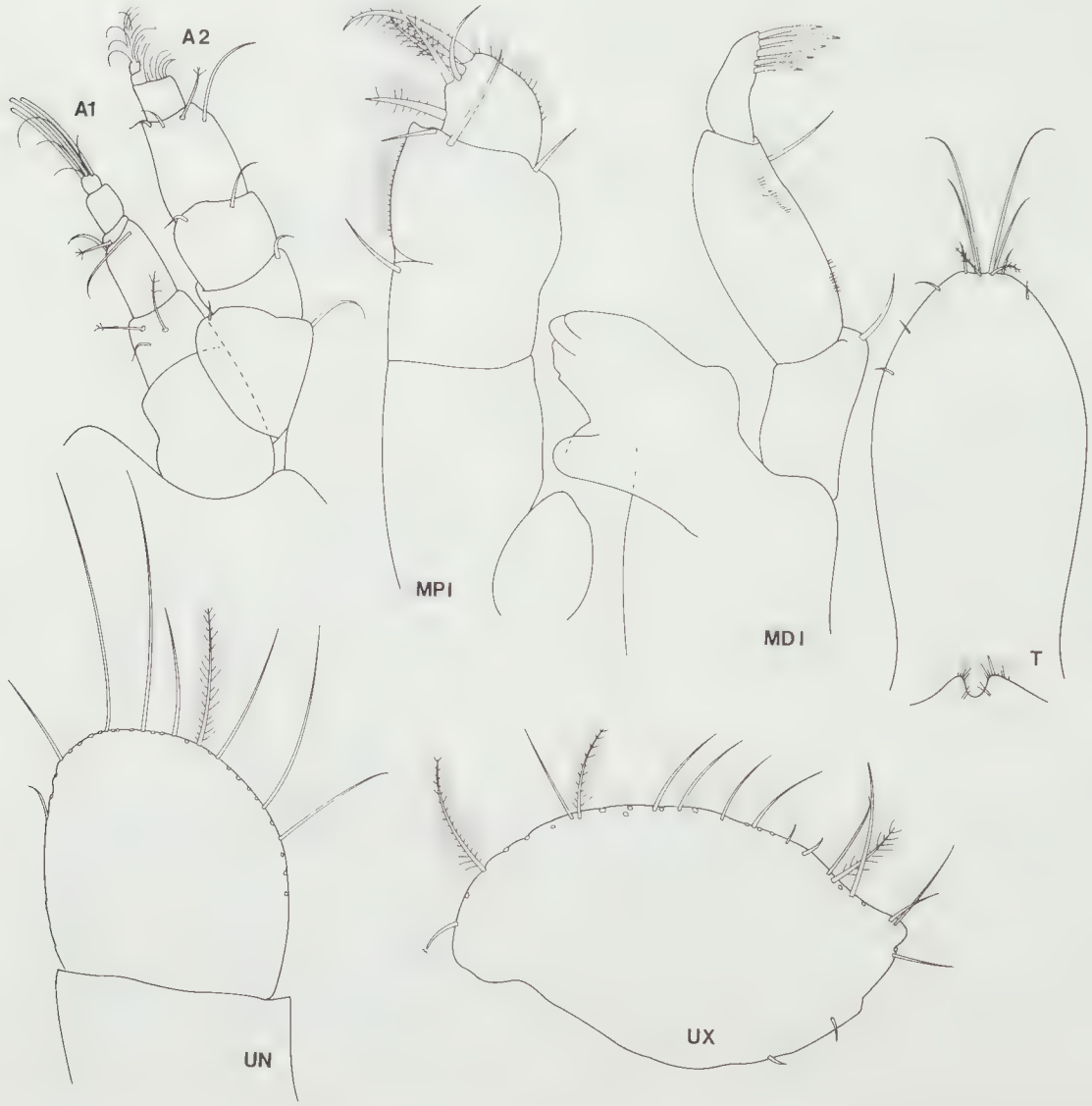

Figure 6. *Chelanthura salvia*, holotype. Antennae, left mandible, maxilliped, telson, uropodal endopod and exopod.

Paratypes. New South Wales. Coffs Harbour (30°18.0′S, 153°09.0′E), 5 m, S. Smith, 11 Jul 1989, NMV J16796 (1 ovigerous female; NMV J17110 (1 preparatory female); AM P40095 (1 preparatory female, 1 ovigerous female).

Diagnosis. Head, pereonites and pleotelson with ill-defined pigment pattern, confined to spots and patches usually symmetrically arranged. Pigment on head moderately extensive and perforated by small nonpigmented areas. Uropods and telson with small spots of pigment.

Antenna 1 peduncle, article 3 twice as long as wide. Antenna 2 peduncle article 4 as wide as long. Mandible with ridged lamina dentata; palp article 3 with 5 marginal setae. Maxillipedal palp with articles 2 and 3 partially fused.

Pereopod 1 propodus robustly ovoid, about 1.2 times as long as wide. Pereopod 1 fixed finger about one-seventh as long as posterior length of fused carpus and propodus, its grinding surface axial-oblique; dactylus inner margin toothed; unguis broad, almost as long as distal margin of dactylus and overlapping apical grinding surface of dactylus.

Pleonite 6 with shallow rounded medial notch on posterior margin. Uropodal endopod slightly wider than long. Telson moderately tapered, widest two-thirds along its length.

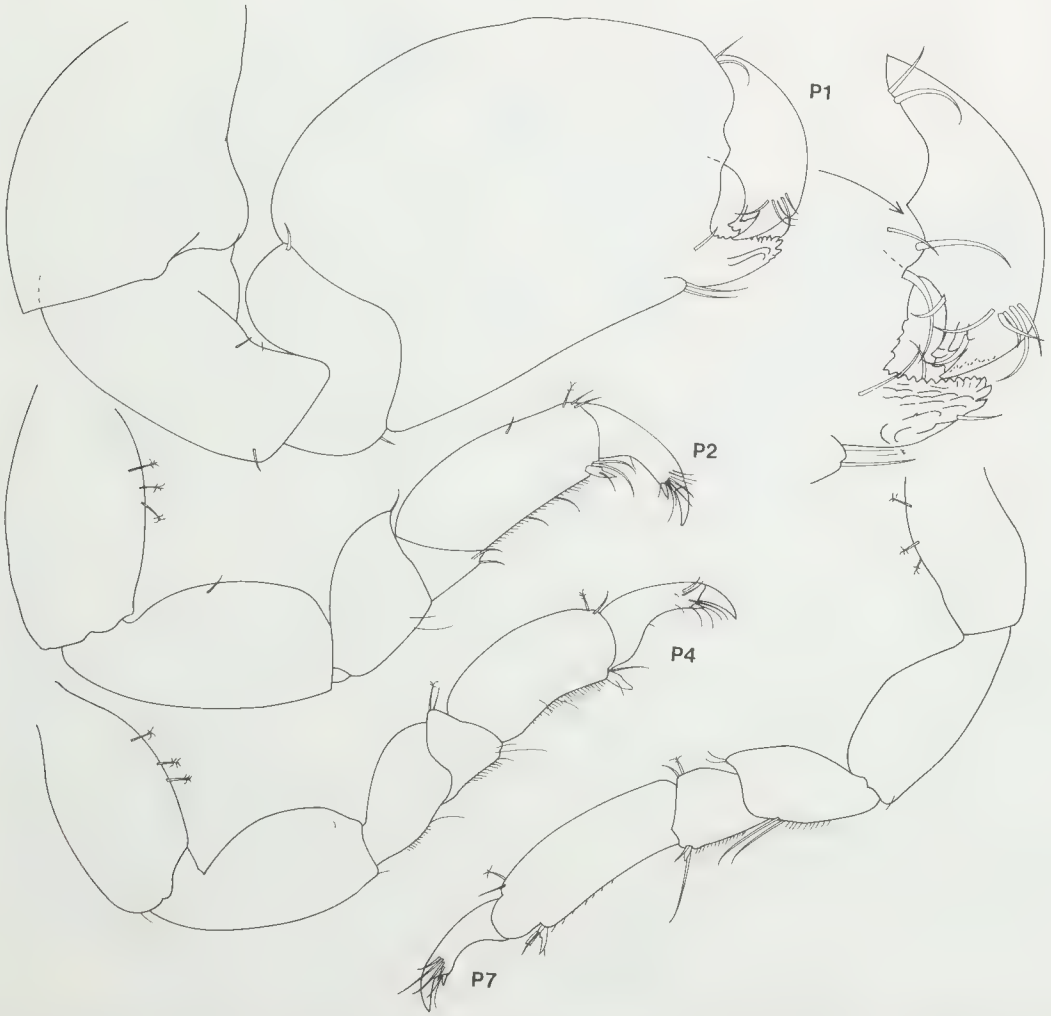

Figure 7. *Chelanthura salvia*, holotype. Pereopod 1 with lateral detail of palm and dactylus, pereopods 2, 4 and 7.

Etymology. Salvia is a genus of flowering plant found in Australia.

Distribution. New South Wales, Coffs Harbour, subtidal.

Chelanthura westringia sp. nov.

Figures 1d, 8, 9

Material examined. Holotype. South Australia. Flinders Island, "The Hotspot" reef, 5 n. miles W of Flinders Island (33°40.80′S, 134°22.50′E), 21 m, large red algae, SCUBA, G.C.B. Poore, on FV Limnos, 20 Apr 1985 (stn SA-69), NMV J16941 (juvenile, 1 slide).

Diagnosis. Head, pereonites and pleotelson with pigment over most of the dorsal surface. Head with a transverse band of pigment between eyes. On pereonites and pleon a pair of longitudinal stripes of pigment run each side of the mid-dorsal line. Lateral patches of pigment on pereonites 5 and 6.

Antennae squat. Antenna 1 article 3 as wide as long, antenna 2 peduncle article 4 2.5 times wide as long. Mandible with lamina dentata of 3 or 4 ill-defined teeth; palp article 3 with 4 setae. Maxillipedal palp with article 2 and 3 fused.

Pereopod 1 fixed finger about one-eighth as long as posterior margin of fused carpus and propodus; its grinding surface oblique. Dactylus inner margin without teeth; unguis attached anterolaterally, at least as long as grinding surface of dactylus, and well produced beyond it.

Pleonite 6 with rounded medial notch on pos-

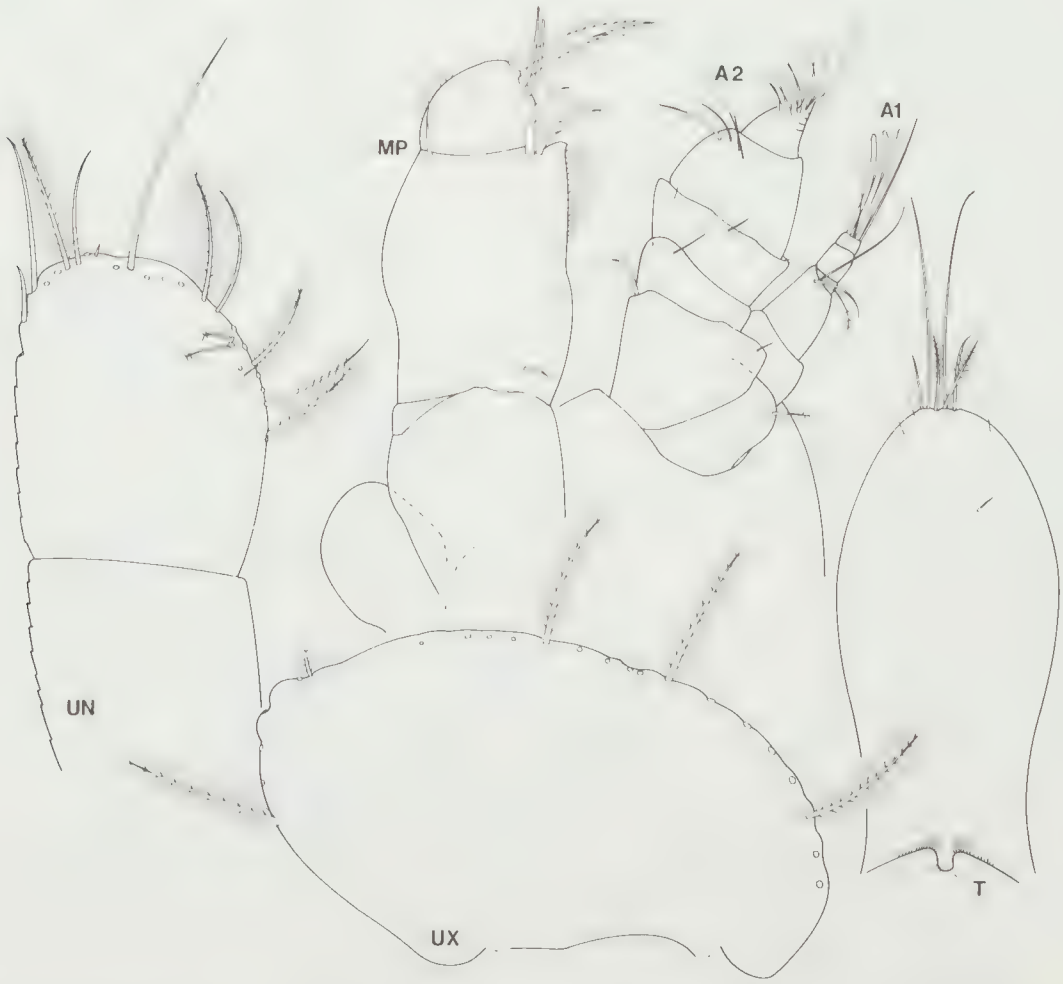

Figure 8. *Chelanthura westringia*, holotype. Antennae, maxilliped, uropodal endopod and exopod, telson.

Figure 9. *Chelanthura westringia*, holotype. Pereopod 1 with mesial and lateral detail of palm and dactylus, pereopods 2 and 7.

terior margin. Uropodal endopod 1.2 times long as wide. Telson moderately tapered.

Etymology. Westringia is a genus of native Australian flowering plant.

Distribution. South Australia; subtidal.

Remarks. Although the unique specimen is incomplete it clearly differs from the other two species. The pigmentation pattern is different, antennae are much broader and the pereopod 1 unguis is well produced.

Acknowledgements

This contribution was made possible through a grant from the Australian Biological Resources Study. We are grateful to Neal Denning who helped by sorting the material and to Graham Milledge who inked the figures. We thank Steve Smith (University of New England) and Graham Edgar (CSIRO, Perth) for donating specimens and Niel Bruce (Queensland Museum) for the loan of material and for critical comments on the manuscript.

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Memoirs of the Museum of Victoria 51: 121–130 (1990) ISSN 0814-1827

LEONTOCARIS AMPLECTIPES SP. NOV. (HIPPOLYTIDAE), A NEW DEEP-WATER SHRIMP FROM SOUTHERN AUSTRALIA

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Abstract

Bruce, A.J., 1990. *Leontocaris amplectipes* sp. nov. (Hippolytidae), a new deep-water shrimp from southern Australia. *Memoirs of the Museum of Victoria* 51(1): 121–130.

Leontocaris amplectipes is described and illustrated, compared with the two other species of the genus, and a key for their identification is provided. The present record is the first occurrence of this little-known genus outside the Atlantic Ocean. A previous suggestion that the genus is associated with coelenterates is supported and a raptorial function for the unusual major chela is suggested.

Introduction

The small hippolytid genus *Leontocaris* was first reported from South African waters by Stebbing (1905), who described a single male specimen of *L. paulsoni* from 240–249 m off Lion Head. Subsequently Kemp (1906) described *L. lar* in the north-west Atlantic Ocean, off Ireland, from about 1000–1300 m, and further material of *L. paulsoni* from South Africa, at 240–265 m, was added by Barnard (1950). The last 40 years have provided no further records despite increased scientific activities in deeper water, particularly in the tropics.

Leontocaris amplectipes sp. nov.

Figures 1–5

Material examined. Holotype, ?male, Victoria, S of Point Hicks (38°21.9′S, 149°20.0′E), 1000 m, WHOI epibenthic sledge, G.C.B. Poore et al. on ORV Franklin, 23 July 1986 (stn SLOPE-32), Museum of Victoria register number J19881.

Description. Small, slenderly built shrimp, of subcylindrical body form, in a fragile state, rather macerated, with abdomen almost separated from cephalothorax, ophthalmic somite damaged, and lacking right antenna, and right third and fifth pereiopods and first and second pleopods.

Carapace smooth, glabrous; rostrum well developed, slender, acute, slightly compressed, straight, horizontal, about 0.65 of carapace length, not exceeding antennular peduncle, reaching to about distal margin of intermediate peduncular segment, extreme tip missing; with 9 acute dorsal teeth, all anterior to posterior orbital margin, decreasing slightly in size distally, dorsal carina without setae; lateral carinae feebly developed; ventral carina with 3 small acute teeth on central third, non-setose; epigastric region with 3 acute teeth, similar to posterior rostral teeth but separated by larger interval, supraorbital and hepatic spines absent, orbit with feeble posterior marginal ridge, inferior orbital angle produced, blunt, antennal spine well developed, exceeding inferior orbital angle, marginal, with distinct carina; anterolateral angle of branchiostegite rounded.

Abdomen smooth, glabrous; third segment feebly produced posterodorsally, without posterodorsal tooth, fifth segment about 0.6 of sixth segment length, sixth segment about 1.8 times longer than deep, compressed, posteroventral angle bluntly produced, posterolateral angle acute. Telson about 1.5 times sixth segment length, 3.0 times longer than anterior width, lateral margins straight, feebly convergent, with 4 pairs of small marginal spines at about 0.3, 0.5, 0.75 and 0.9 of telson length, posterior margin about 0.8 of anterior margin width, broadly rounded, without median process, with 4 pairs of short simple spines, lateral posterior spines slightly larger than lateral marginal spines, submedian spines about 0.085 of telson length, 2.0 times lateral posterior spine length.

Antennule distinctly exceeding rostrum, with proximal segment of peduncle subcylindrical slender, about 4.0 times as long as distal width, unarmed, stylocerite short, broad, with small lateral tooth, statocyst obsolete; intermediate

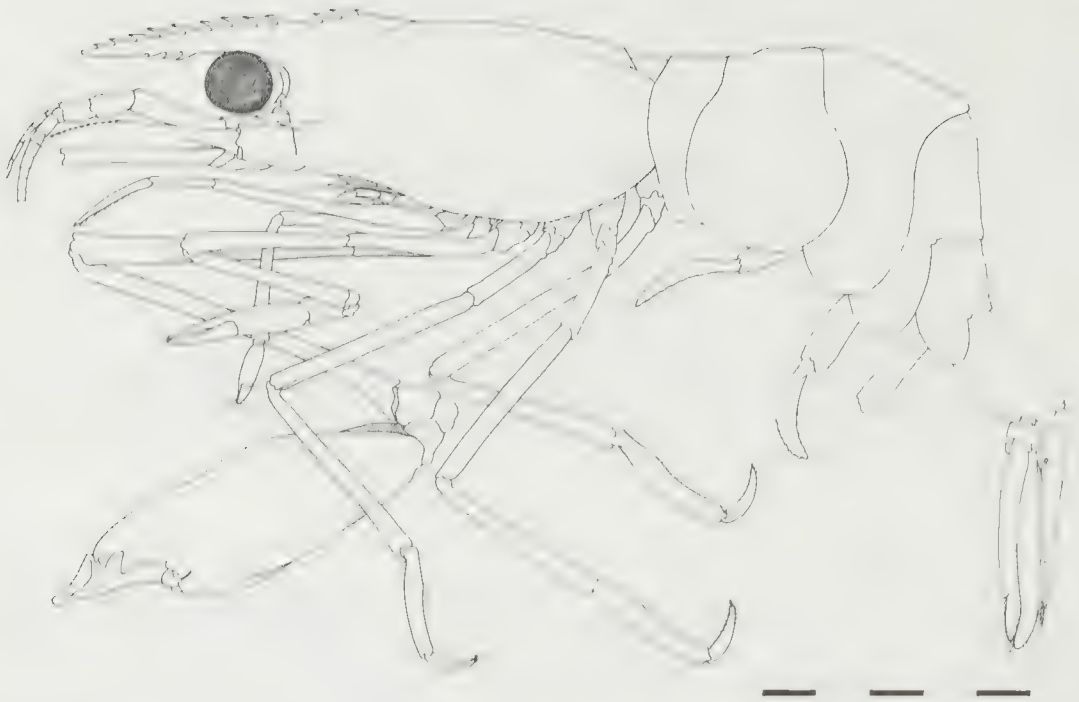

Figure 1. *Leontocaris amplectipes* sp. nov., ?male, holotype, Victoria, 1000 m. Scale bar in millimetres.

segment about 0.38 of proximal segment length, subcylindrical, unarmed; distal segment about 0.26 of proximal segment length, subcylindrical, unarmed; flagella damaged, upper flagellum robust, lower flagellum slender.

Antenna with stout, unarmed basicerite, ischiocerite normal, merocerite small, carpocerite elongate, slender, subcylindrical, about 9.0 times as long as distal width, reaching to distal end of antennular peduncle, flagellum lacking; scaphocerite well developed, exceeding antennular peduncle, broad, about 2.6 times as long as central width, proximal half of lateral margin straight, entire, distal half feebly convex with 11 small acute teeth, distal lamella broadly rounded, distinctly exceeding distal lateral tooth.

Eye with large globular cornea, diameter about 0.2 of carapace length, well pigmented, without accessary pigment spot; stalk short, broad, length about 0.75 of width, 0.6 of corneal diameter.

Epistome unarmed; labrum normal; anterior thoracic sternites narrow, posterior sternites broad, fifth with small elongate median boss, sixth with larger hemispherical eminence, seventh with small anterolateral rounded lobes, eighth unarmed.

Mandible (right) with single segmented palp, slender, about 3.0 times longer than wide, with single simple distal seta; molar process normal, distally excavate, with 2 blunt posterior teeth, with dense mass of marginal setae, short, simple, slender proximally, larger, stouter distally, with numerous blunt denticles distally; incisor process normal, obliquely truncate distally, with 6 acute teeth, medial and lateral teeth larger than central teeth; maxillula with slender, feebly bilobed palp, upper lobe rounded, with long slender feebly plumose seta, lower lobe angular, with short simple seta; upper lacinia broadened centrally, distal border with double row of about 14 short stout simple spines and numerous simple setae; lower lacinia slender, tapering distally, with numerous long simple setae. Maxilla with short, slender palp, medially emarginate, with single long plumose distal seta, basal endite deeply bilobed, distal lobe broader than proximal, both with numerous simple setae distally, coxal endite simple, short, broad, rounded, sparsely setose; scaphognathite about 3.2 times longer than broad, posterior lobe slender, about

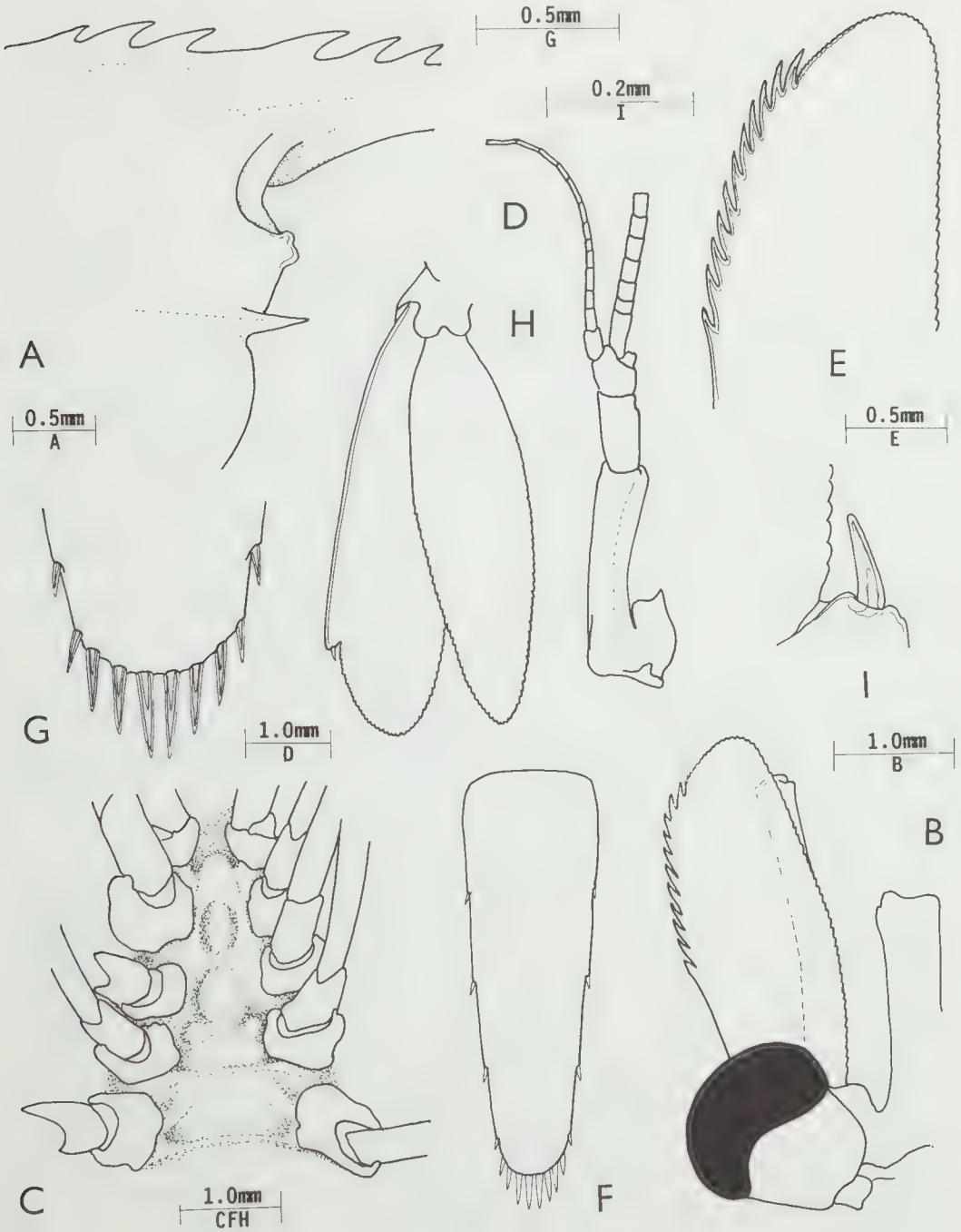

Figure 2. *Leontocaris amplectipes* sp. nov., holotype. A, anterolateral carapace, orbital region. B, eye and antennular region, dorsal C, thoracic sternites. D, antennule. E, scaphocerite, distal half. F, telson. G, same, posterior spines. H, uropod. I, same, distolateral spine of exopod.

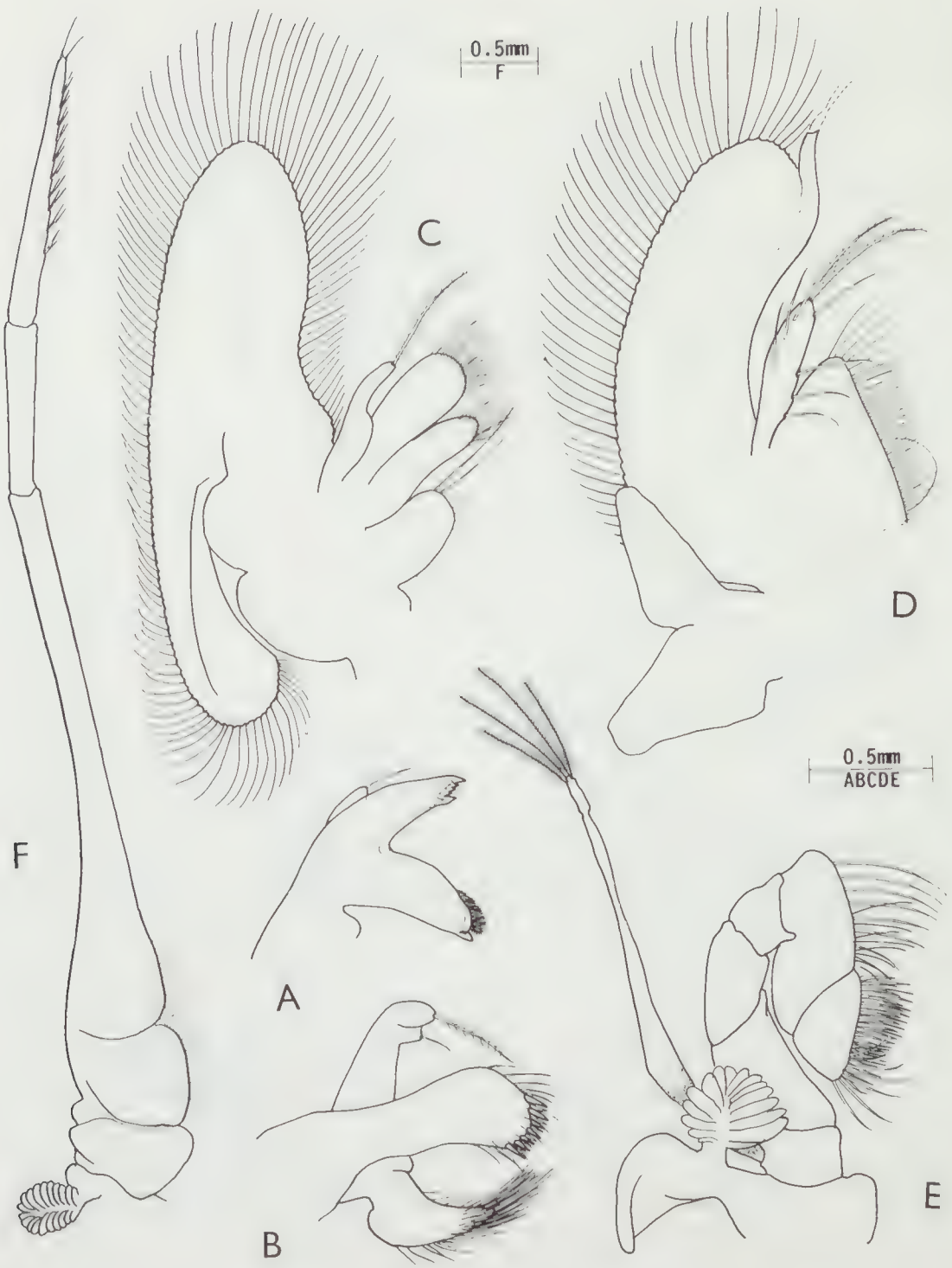

Figure 3. *Leontocaris amplectipes* sp. nov., holotype. A, mandible. B, maxillula. C, maxilla. D, first maxilliped. E, second maxilliped. F, third maxilliped.

4.2 times longer than anterior width, slightly expanded distally, anterior lobe broad, 1.6 times longer than wide, medial margin feebly emarginate. First maxilliped with short subcylindrical palp, with 2 plumose distal setae, several preterminal simple setae, basal endite angular, densely setose medially, coxal endite lost in dissection, exopod with large, broad caridean lobe, flagellum feebly developed, with vestigial setation; epipod large, deeply bilobed. Second maxilliped with normal endopod, dactylar segment short, broad, 1.8 times longer than wide, densely setose medially, setae denticulate, obliquely articulated with propodal segment, 2.5 times longer than wide, medial margin with long spiniform setae, simple proximally, feebly denticulate distally, proximal segments of endopod normal, coxa produced medially, exopod with slender flagellum with 4 plumose setae distally, epipod simple, with podobranch. Third maxilliped slender, extending to distal margin of scaphocerite, exceeding antennular peduncle, ischiomerus distinct from basis medially, about 5.6 times longer than proximal width, broadly expanded proximally, slender, subcylindrical distally, with few simple setae proximomedially, penultimate segment subcylindrical, about 5.3 times longer than wide, 0.3 of ischial length, distal segment subcylindrical, about 10.5 times longer than proximal width, tapering distally, 0.5 of ischial length, with numerous groups of short simple spines distoventrally, few feeble setae distally; basis broad, about 1.9 of ischial length, sparsely setose medially, without exopod; coxa feebly produced medially, without epipod or lateral plate, with well developed small arthrobranch.

First pereiopods similar, small, slender, reaching to about middle of intermediate segment of antennular peduncle; chela small, with palm subcylindrical, slightly compressed, about 2.0 times longer than deep; dactylus about 0.5 of palm length, stout, broad, ventrally concave, with small acute hooked tip, dense arc of short setae distodorsally; fixed finger, slender, subcylindrical, with small acute hooked tip; carpus about 2.3 times chela length, subcylindrical, unarmed, about 8.0 times longer than distal width, tapered proximally, with small setose depression distoventrally; merus about 0.75 of carpal length, 6.0 times longer than central width, generally uniform, slightly expanded distoventrally, unarmed; ischium 0.5 of carpal length, 5.0 times longer than distal width, unarmed; basis short, without exopod; coxa robust, without epipod or arthrobranch.

Second pereiopods grossly unequal, dissimilar. Major pereiopod (right) exceeding antennal peduncle by carpus and chela; chela with palm smooth, glabrous, about 3.3 times longer than central width, subcylindrical with well developed ventral flange, with a deep narrow submarginal fissure along central medial third, irregular distodorsally; dactylus strongly compressed, laminar, far exceeding fixed finger, about 2.3 times longer than central depth, lateral margin broadly rounded, far over reaching small blunt distal tooth, curved laterally, cutting edge curved medially, with large acute central tooth separated by deep notches from small proximal tooth and blunt distal tooth; fixed finger stout, about as long as deep, moderately compressed, distally with blunt rounded tip, large irregular preterminal tooth separated by deep notch from proximal acute tooth; fixed finger stout, about as long as deep, moderately compressed, distally with blunt rounded tip, large irregular preterminal tooth separated by deep notch from proximal acute tooth, with 5 smaller denticles proximally, notches with scattered simple setae medially; carpus long and slender, unarmed, 4-segmented with proximal segment about 1.3 times palm length, subcylindrical, moderately expanded distally, about 18.5 times longer than central width, 3 distal segments subequal, quadrate, irregular, about 0.1 of proximal segment length; merus about 0.6 of proximal carpal segment length, slender, slightly expanded distally, about 12.0 times longer than central width, unarmed, with distinct flange proximomedially; ischium 0.5 of merus length, about 5.0 times longer than central width, unarmed, with feeble ventromedial flange; basis and coxa normal, without special features; exopod, epipod and arthrobranch lacking.

Minor second pereiopod with proximal carpal segment extending to about end of antennular peduncle; chela small, about 0.45 of carapace length, palm smooth, subcylindrical, feebly compressed, forcipulate, about 2.6 times longer than deep; fingers slender, about 0.9 of palm length, dactylus tapering, about 5.0 times longer than proximal width, distally feebly spatulate, with serrate cutting edges medially and laterally, small acute hooked tooth distally; fixed finger similar, spatulate, with 2 small distal teeth; carpus 4-segmented, distal segment robust, unarmed, about 0.5 of palm length, 2 central segments short, stout, 0.3 of palm length, unarmed, proximal segment elongate, subequal to length of chela and distal carpal segment, about 7.0 times longer than distal width, 2.0 times wider distally than proximally, unarmed; merus about

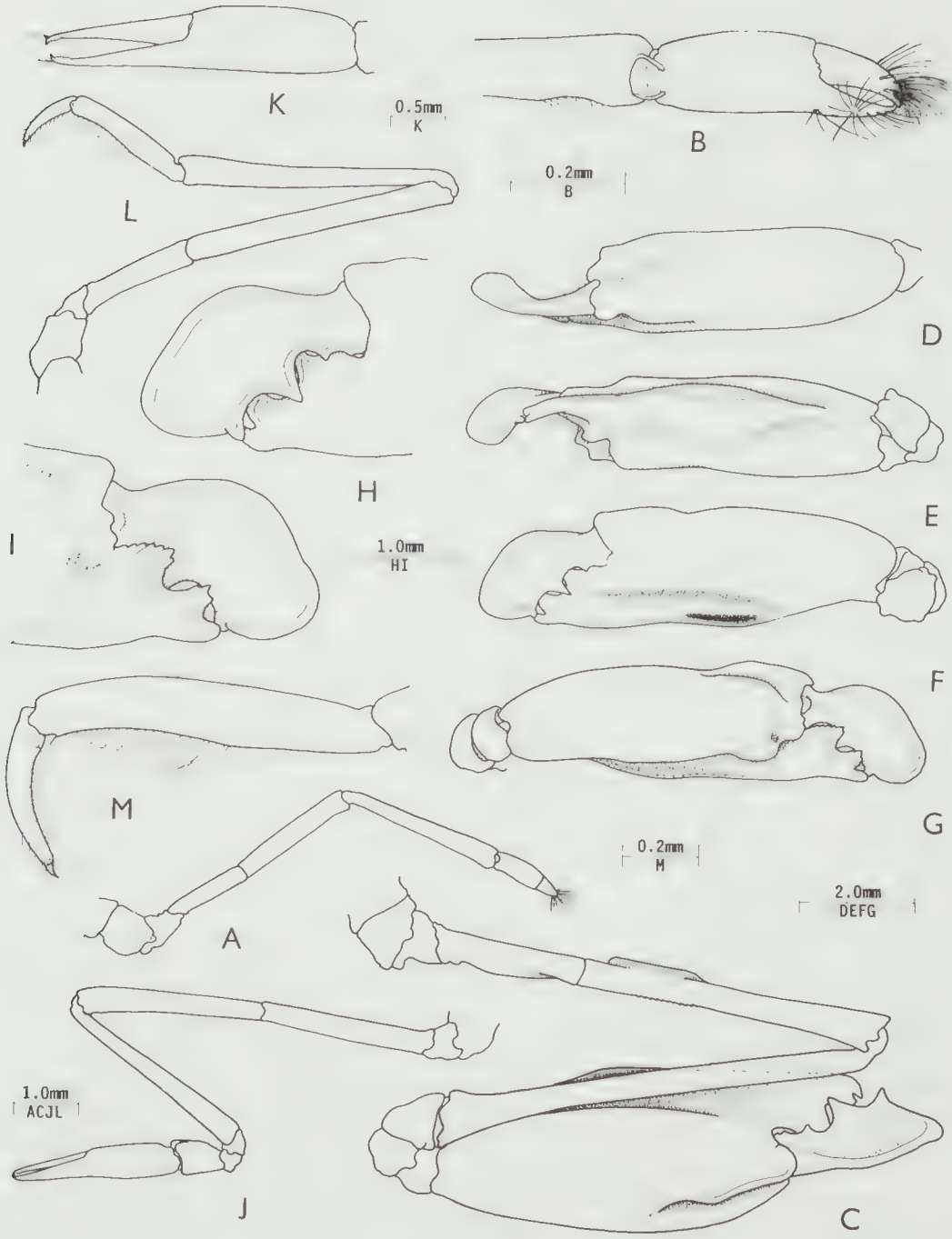

Figure 4. *Leontocaris amplectipes* sp. nov., holotype. A, first pereiopod. B, same, chela. C, major second pereiopod. D–G, same, chela. H, same, fingers, medial, I, same, lateral. J, minor second pereiopod. K, same, chela. L, fourth pereiopod. M, same, dactylus and propod.

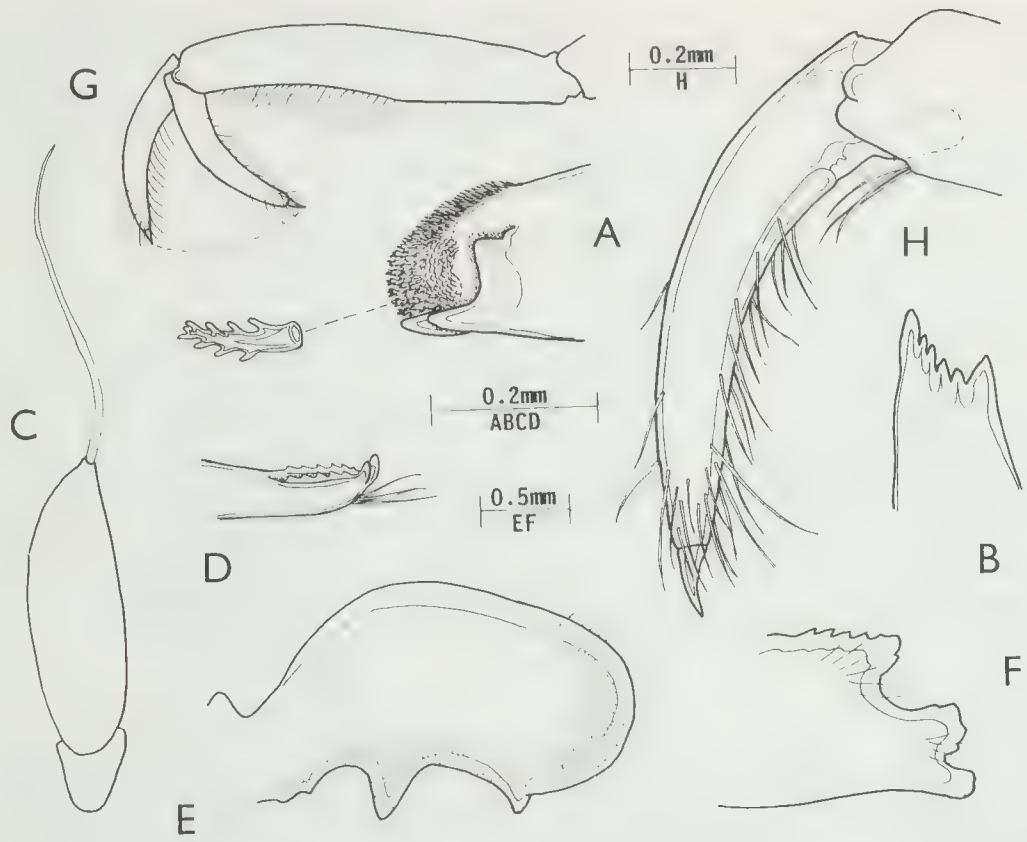

Figure 5. *Leontocaris amplectipes* sp. nov., holotype. A, mandible, molar process; inset, marginal spine (not to scale). B, same, incisor process. C, same, palp. D, minor second pereiopod, tip of dactylus. E, major second pereiopod, dactylus. F, same, fixed fingers. G, fourth pereiopod, not to scale, indicating range of dactylar movement. H, fourth pereiopod, dactylus.

0.9 of proximal carpal segment length, 6.5 times longer than distal width, feebly tapering proximally, unarmed; ischium about 0.95 of meral length, 7.5 times longer than central width, unarmed; basis and coxa short, stout, without special features.

Ambulatory pereiopods moderately slender. Third pereiopod with carpus reaching to about distal antennular peduncle; dactylus robust, subcylindrical, feebly curved ventrally, about 0.5 of propod length; unguis distinctly demarcated, short, conical about 2.5 times longer than basal width, simple, curved, about 0.12 of corpus length, corpus about 5.0 times longer than proximal width, tapering feebly distally, simple, ventral border concave, without accessary spines or teeth, with numerous scattered simple setae; propod about 6.0 times longer than central width, 0.33 of carapace length, slightly bowed, distal 0.45 ventrally concave, with numerous long simple setae, ventral margin without spines; carpus slender, about 2.0 times propod length, about 10.5 times longer than distal width, unarmed; merus subequal to propod length, unarmed; ischium about 0.43 of merus length, unarmed; basis and coxa normal, without special features; without exopod, epipod or arthrobranch. Fourth and fifth pereiopods generally similar, propods subequal, about 1.25 third propod length; carpus subequal, about 0.9 of third carpus lengths; merus subequal, about 0.8 of third merus length.

Pleopods damaged, first and second pairs completely lacking, posterior pairs incomplete.

Uropods with protopodite normal, unarmed; exopod subequal to endopod, distinctly exceed-

ing posterior margin of telson, about 3.6 times longer than wide, lateral margin convex proximally, straight, entire, with small mobile spines distally, diaeresis feebly indicated.

Measurements. Total body length (approx.), 25.7 mm; carapace and rostrum, 10.0 mm; carapace, 6.2 mm; major second pereiopod, chela, 7.8 mm; minor second pereiopod, chela, 2.8 mm.

Colour. No data.

Etymology. From *amplector*, to embrace, and

Table 1. Comparison of the three species of *Leontocaris.*

L. paulsoni Stebbing	*L. lar* Kemp	*L. amplectipes* sp. nov.
Rostrum distinctly exceeding carapace length and antennular peduncle	Rostrum distinctly exceeding carapace length and antennular peduncle	Rostrum much shorter than carapace length, not exceeding antennular peduncle
Rostrum with 6 dorsal and 6–8 ventral teeth.	Rostrum with 9 or 10 dorsal and 9–13 ventral teeth.	Rostrum with 9 dorsal and 3 ventral teeth.
2 epigastric teeth	3 epigastric teeth	3 epigastric teeth
Inferior orbital angle acute	Inferior orbital angle acute	Inferior orbital angle blunt
Scaphocerite with strong distolateral tooth, with 19 distolateral teeth	Scaphocerite without strong distolateral tooth, with 17 distolateral teeth	Scaphocerite without strong distolateral tooth, with 11 distolateral teeth
Cornea reduced, narrower than stalk	Cornea well developed, broader than stalk	Cornea well developed, broader than stalk
Second pereiopod with fixed finger teeth very slender, acute, simple	Second pereiopod with fixed teeth acute, simple	Second pereiopod with fixed finger teeth short, stout, blunt, denticulate
Third pereiopod with dactylus about 0.25 of propod length, propod subequal to carpal length	Third pereiopod with dactylus about 0.2 of propod length, propod subequal to carpal length	Third pereiopod with dactylus about 0.5 of propod length, propod about 0.5 of carpal length
Third abdominal segment with posterodorsal tooth	Third abdominal segment posterodorsally unarmed	Third abdominal segment posterodorsally unarmed
Pleuron of fifth abdominal segment with posterior tooth	Pleuron of fifth abdominal segment with posterior tooth	Pleuron of fifth abdominal segment rounded, unarmed
Telson with 5 pairs of marginal dorsal spines; posterior margin acute, bifid, with 2 pairs of spines	Telson with 5 pairs of marginal dorsal spines; posterior margin broadly rounded, with 3 pairs of spines	Telson with 4 pairs of marginal dorsal spines; posterior margin broadly rounded, with 4 pairs of spines

pes, foot (Latin) referring to the prehensile appearance of the ambulatory pereiopods.

Associated fauna. Three small hippolytid shrimps, badly damaged and unidentifiable to genus level.

Systematic position. The two other species of the genus, *L. paulsoni* Stebbing and *L. lar* Kemp, appear more closely related to each other than to *L. amplectipes*. The major features of the three species are outlined in Table 1.

Key to the species of *Leontocaris* Stebbing, 1905

1. Rostrum exceeding carapace length, with 8 or more ventral teeth; ambulatory pereiopod with dactylus much less than 0.5 of propod length; fifth pleuron with small posterior tooth; exopod of uropod distolaterally serrate 2
— Rostrum much shorter than carapace length, with 3 ventral teeth only; ambulatory pereiopod with dactylus about 0.5 of propod length; fifth pleuron posteriorly unarmed; exopod of uropod distolaterally entire, with small mobile spine only ..... *L. amplectipes* sp. nov.
2. Rostrum with 9–10 dorsal teeth; distolateral tooth of scaphocerite small; cornea large; third abdominal segment without posterodorsal tooth; posterior margin of telson rounded ..... *L. lar* Kemp
— Rostrum with 6 dorsal teeth; distolateral tooth of scaphocerite large; cornea small; third abdominal segment with posterodorsal tooth; posterior margin of telson bifid ..... *L. paulsoni* Stebbing

Discussion

The discovery of a third species of the genus *Leontocaris* in Australian waters provides a significant extension to the known geographic range of the genus and the first record of its occurrence outside the Atlantic Ocean. The additional species confirms Barnard's (1950) diagnosis of the genus.

The functions of the unusual but diagnostic major chela remain obscure. As noted by Kemp (1910) when extended it can be almost equal to the entire length of the shrimp, but at the same time it is capable of being folded away in an inconspicuous position beneath the body. The long proximal segment of the carpus lies in the longitudinal groove lateral to the flange along the ante-dactylar border of the palm and is probably held in place by the merus, which bears a proximal medial flange which can fit exactly into the deep groove in the central portion of the palmar flange. Kemp (1910) reported a thin-walled sausage-shaped structure arising from an extra deep area of this groove. It is suggested that the floor of this fossa is feebly calcified and has been everted by post-mortem swelling in the case of Kemp's material – which as he states, is very variable. This locking mechanism suggests that the limb may be capable of rapid extension and may have a predatory function, similar to that of the raptorial claws in stomatopods (Fig. 6).

The proximal ventral margin of the merus of the major second pereiopod shows a row of small serrations. In both *L. paulsoni* and *L. lar*, these have small spines attached (Barnard, 1950; Kemp, 1910), which have presumably been lost in the present specimen. From their positions, these spines would appear to be related to the locking mechanism between merus and palm but their exact function is not obvious.

The ecological niche occupied by species of *Leontocaris* remains unknown. Kemp (1910) suggested an association with coelenterates (*Antipatharia* and *Lophohelia*). A commensal life-style is also suggested by the prehensile appearance and limited range of movement in the dactylus and propod of the ambulatory pereiopods in *L. amplectipes*, although this feature is less conspicuous in the other two species of the genus. The limited range of dactylar movement appears to be compensated for by an increased range of movement in the carpo-propodal joint, where an unusually large degree of extension is possible. The arrangement resembles that found in many chirostylids, many of which are found in association with coelenterate hosts.

The three species of *Leontocaris* now known all occur in deep water. *Leontocaris paulsoni* has been reported from 246–269 m (Stebbing, 1906) and 240–265 m (Barnard, 1950); *L. lar* is known from 914 m and 1146–1368 m (Kemp, 1910).

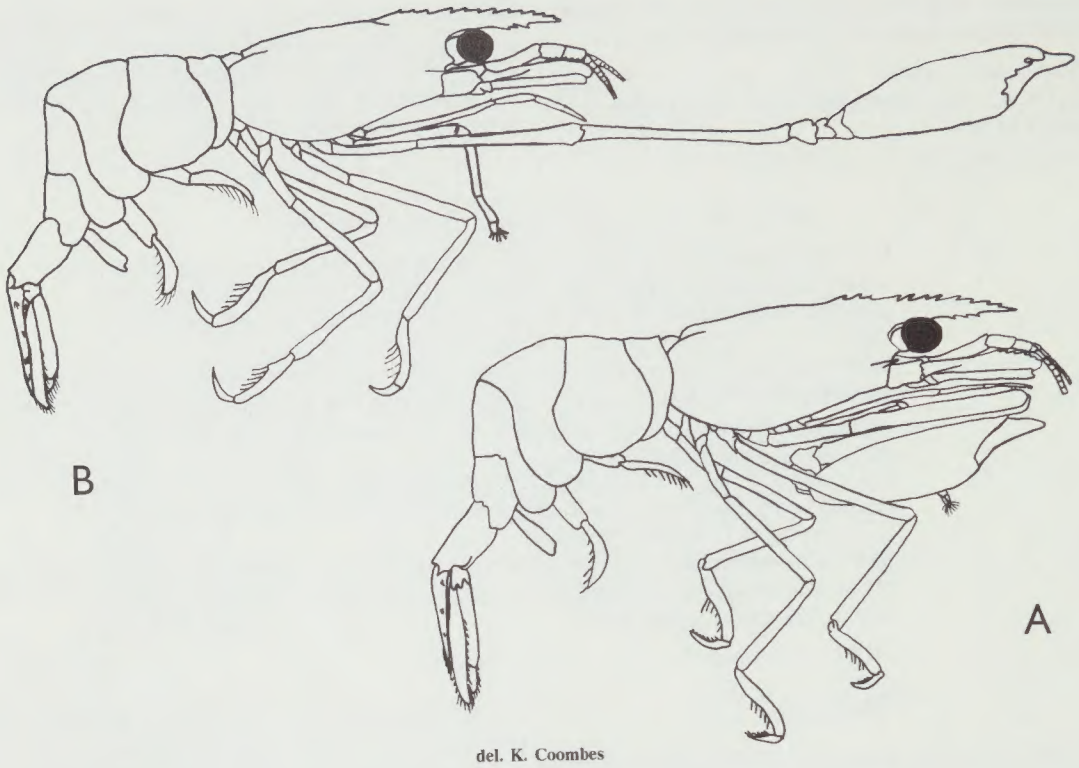

Figure 6. *Leontocaris amplectipes* sp. nov. A, with major first pereiopod flexed. B, with major second pereiopod extended.

The new species, at 1000 m, lies at the deeper end of the range of the genus.

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CONTENTS